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A METHOD FOR SAMPLING DUST IN ALVEOLAR AIR*

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INTRODUCTION

THE physical character, the size, and the chemical composition of dust particles that reach the alveoli of the lungs by inhalation have generally been studied after they have become fixed in the lung tissue, or after they have been ingested in the alveoli by the phagocytic action of the "dust cells." When these cells have gathered their load of particles, presumably in the alveoli, some of them wander within reach of the ciliated epithelium, and thence are eventually expelled in the sputum. Dust in sputum can be examined, measured, and analyzed chemically from suitable microscopic mounts. It should be borne in mind, however, that dust thus examined may have become contaminated with dust from the upper respiratory passages. From the dust in sputum, one cannot make final conclusions as to the character of the particles reaching the depths of the lungs, and it is these particles with which reckoning must be made in estimating possibilities of lung damage.

Dust reaching the alveoli by inhalation is not expelled by normal exhalation, but is retained there by settling or diffusing to the moist walls. If the dust content of the alveolar air can be immediately determined, it may be possible to predict the damage that is likely to result from the inhalation of toxic substances.

This paper is devoted to the discussion of a method and apparatus for sampling alveolar dust.

REVIEW OF THE LITERATURE

In his experiments on the scattering and reflection of light by minute particles suspended in air, Tyndall (1) in 1882 described an experiment which ap-

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pears to substantiate Lister's hypothesis that alveolar air is dust free and cannot, therefore, cause putrefaction. Tyndall inhaled air from a dusty room, exhaled through a glass tube warmed in order to prevent condensation of moisture, and focused the beam of an arc light on the exhaust end of the tube. Toward the end of an expiration, he noted a "clear dark space" across the path of the beam of light—the clear space indicating freedom from suspended matter. He inferred from this that the deeper parts of the lungs were filled with optically pure air, containing no organisms which could give rise to putrefaction.

In 1921, Owens gave an interesting account of the use of his jet dust counter (2) in which he showed that alveolar air was not dust free—a fact which, he believes, Tyndall failed to discover because his method for detecting the dust was not sufficiently sensitive.

From the hygienic point of view, it is more accurate to use a method which permits microscopic examination of the exhaled dust. For all studies of the sort in this laboratory, we use suspensions of dusts, fumes, or smokes of known or negligible toxic properties. From a carefully chosen group of such suspensions, it is possible to predict, with some assurance, the dust content of alveolar air on breathing the more dangerous suspensions like silica dust or lead and arsenic fumes.

The Alveolar Dust Sampler

A convenient apparatus for sampling alveolar dust can be devised by modifying one of three types now commonly used for sampling aerial dust. Better still, a combination of features of all three would serve the purpose admirably. These three types are (*a*) Owens' jet dust counter (3), (*b*) the Kotzé konimeter as used in the South African mines (4), and (*c*) Hill's dust counting apparatus (5).

In Owens' apparatus, the dusty air is first saturated with moisture and then projected through a slot, 0.1 mm. wide and 1 cm. long, on to a dry cover glass. The fall of pressure, due to the high air velocity through the slot, condenses moisture on the dust particles, which are thus projected wet against the cover glass. The water evaporates very rapidly and leaves the particles adhering to the glass in the shape of a fine ribbon (Fig. 2).

The same principle is applied in the konimeter and in Hill's apparatus, except that the air is not first saturated and the particles are projected dry against a cover glass smeared with an adherent like vaseline or egg albumin.

Since alveolar air containing dust is virtually saturated with moisture and its temperature is nearly 98°F., the use of adherents is unnecessary, provided the air velocity is high and the temperature of the air drops appreciably on passing through the orifice.

Figure 1 shows a modified Owens apparatus arranged for sampling alveolar dust. A is a 50-c.c. pump and B a chamber connected to A containing the cover glass on which the dust ribbon is impinged. Chamber B is connected to a receiving tube D which contains the alveolar air exhaled by the subject through the side inlet C.

Sampling.—In the process of sampling, a cover glass is first inserted in B. At the end of an expiration, the subject places his mouth over the opening C, exhales forcibly into the receiving tube D, then seals the inlet C by placing his tongue over it, and immediately takes one or two strokes on the pump A. This draws the dusty air from tube D and impinges the dust on the dry cover glass, the air escaping into the room through the valve in the pump. The cover glass is then removed and mounted for microscopy or microchemical analysis in any manner desired.

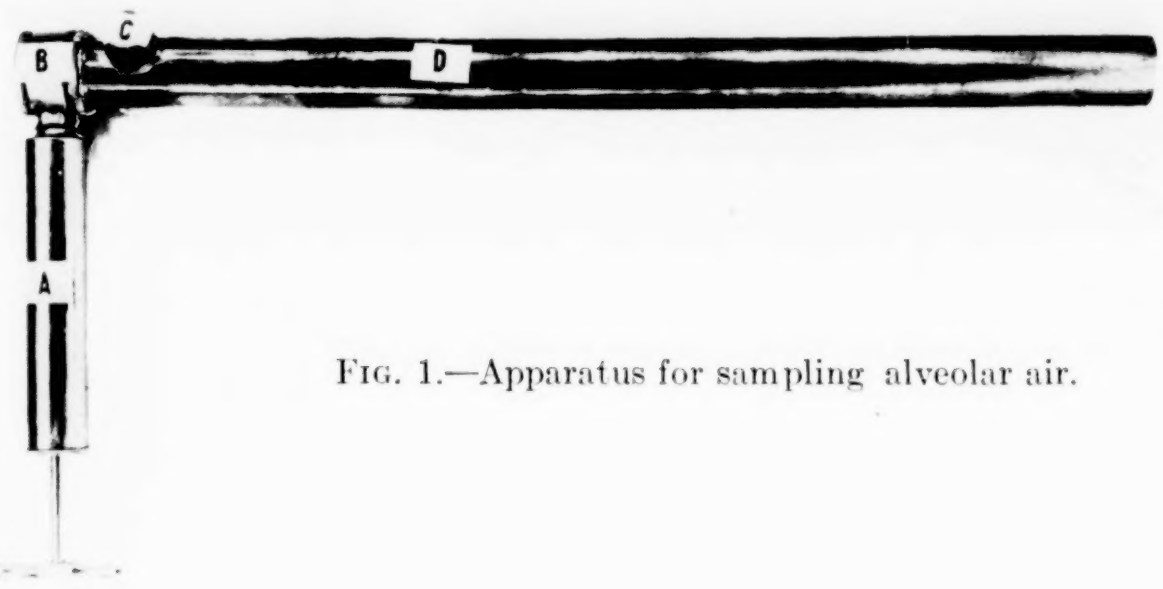


FIG. 1.—Apparatus for sampling alveolar air.

Before another sample is taken, C is closed with the hand, and the open end of the receiving tube D is connected to a filter of cotton, packed in a glass tube. Several strokes of the pump serve to flush out the receiving tube thoroughly. For sampling alveolar dust, this tube should have a capacity of at least 300 c.c. In our later experiments, the inlet C was fitted with a stopcock, making it unnecessary to close the inlet with the tongue while taking a sample. It has also been found convenient to have only a part of tube D made of metal and the remainder of rigid rubber tubing with about a 2-cm. bore. This gives the subject greater freedom in working the apparatus.

It is important that the sample of alveolar dust be taken immediately after the tube D has been filled and before it has been moved about. Otherwise, the sample will be contaminated by dust from the room air, as can easily be shown by analyses. For this reason, it would be well to operate the pump A by a spring release, as in the Kotzé konimeter. With a pump of 100-c.c. capacity, like Hill's, this could be arranged in graduated form to give 25-c.c., 50-c.c., 75-c.c., and 100-c.c. samples, according to the concentrations of dust inhaled.

COMPOSITION OF AIR SAMPLED

The simplest way to prove that dust collected by this method is truly alveolar is to determine the carbon dioxide content of the air exhaled into the tube D. This was done in the following manner.

A rubber stopper fitted with a glass tube was inserted at C. A short piece of rubber tubing with a suitable clamp was attached to the glass tube.

At the end of a normal exhalation, the subject exhaled forcibly through the rubber tube, sealing it first with his tongue and finally with the clamp. Analyses for the carbon dioxide content of the air in D were made at once on the Haldane gas analysis apparatus by withdrawing a small portion of the air directly into the gas analyzer.[1] The receiving tube D should be filled three times with the exhaled air and one sample taken for analysis from each exhalation, as follows: (*a*) immediately after a forcible expiration; (*b*) after the first stroke on the pump; and (*c*) after the second stroke on the pump.

The following results from one subject are typical:

Strokes of Pump	*Carbon Dioxide* %
none	5.38
1 (50 c.c.)	5.42
2 (100 c.c.)	5.12

It is clear that the air in tube D, in the immediate vicinity of C, represents true alveolar air. It is justifiable, therefore, to assume that dust sampled by one or two strokes of the pump represents true alveolar dust.

Experiments in Dusty Air

In connection with experiments now in progress in this laboratory on the inhalation of dusts, fumes, and smokes, numerous samples of alveolar dust have been obtained by the method described. Various concentrations of the suspensions were used, and rates and depth of breathing were varied. Some samples were taken from subjects who had entered the dusty atmosphere for a minute or two, and others were taken from subjects who had breathed known concentrations for as long as twenty minutes through a large face mask especially adapted for the purpose. The actual sampling never took more than five or six seconds.

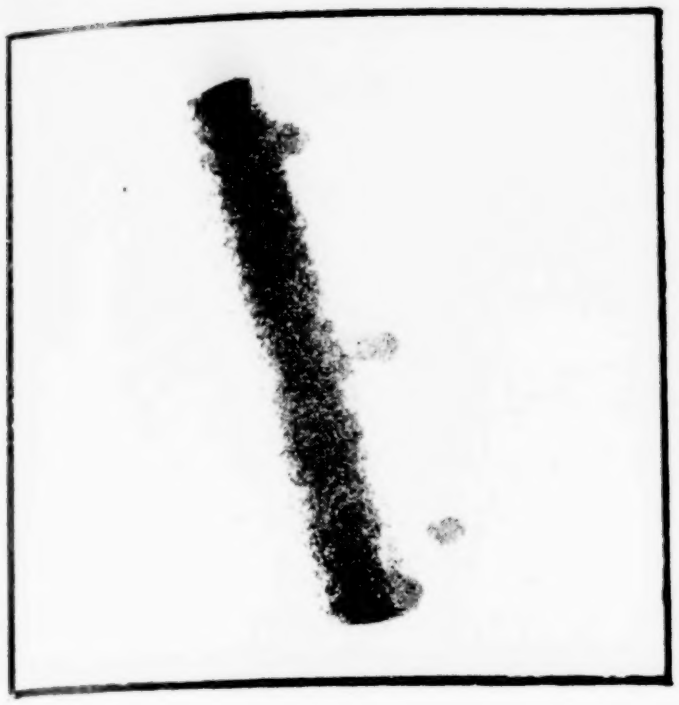
Figures 2 and 3 show photomicrographs of high and low magnification from a 100-c.c. sample given up by a subject after less than a minute in the dust cabinet of this laboratory (7). The cabinet had a high carbon dioxide content (8) and had been filled with gas black—very fine carbon particles—by means of an ejector.

Figures 4 and 5 show a 100-c.c. sample of ore dust containing at least five different minerals. The subject in this case took five deep breaths through the mask for a period of one minute.

Figures 6 and 7 show a 100-c.c. sample of zinc oxide fume from a subject who had breathed the fume for fifteen minutes at six breaths a minute. The zinc oxide was generated by an electric furnace and allowed to diffuse through the cabinet.

The photomicrographs in Figures 2 to 7 were chosen for reproduction because they bring out some significant points in the use of this method. Referring to Figures 2 and 3 showing carbon black inhalation in an atmosphere containing 10 per cent. of carbon dioxide, it will be observed that the particles are deposited in a matrix, probably of mucus. This does not occur in sampling from a subject breathing normally, and accompanies

[1] According to Haldane (6), to obtain alveolar air, the volume of air expired must be at least 800 c.c., in order that mixing with air from the apparent dead space of the lungs may be avoided.



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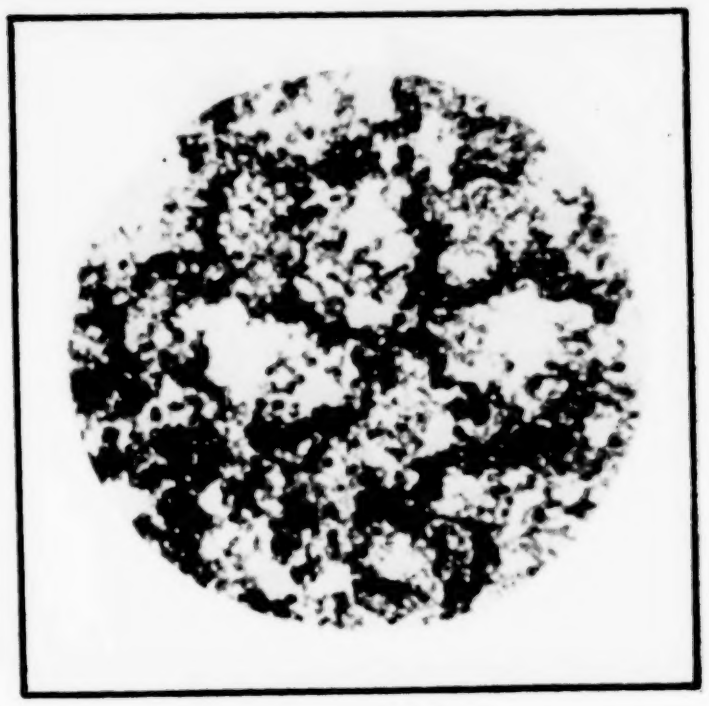

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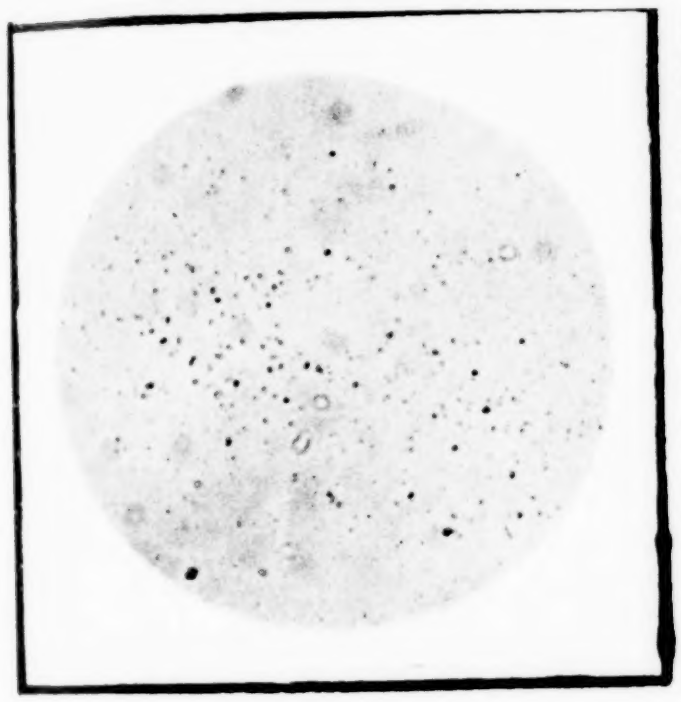

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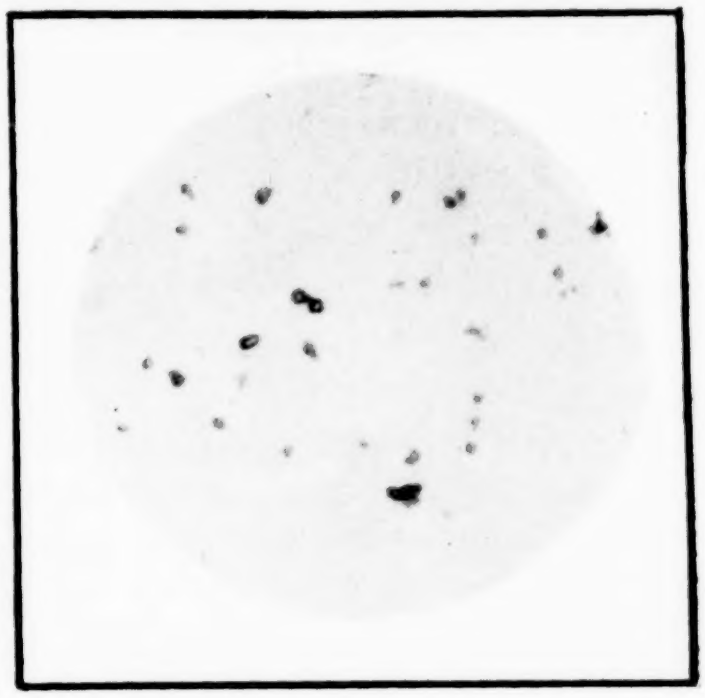

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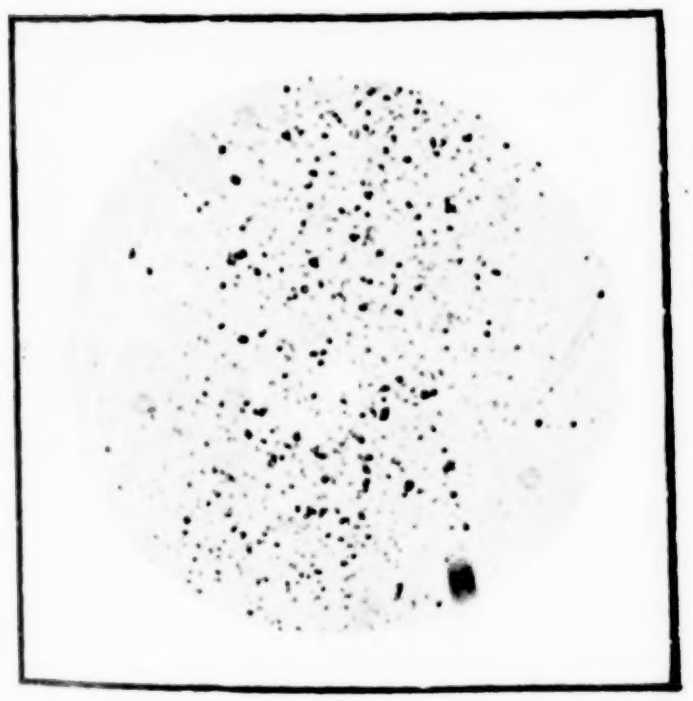

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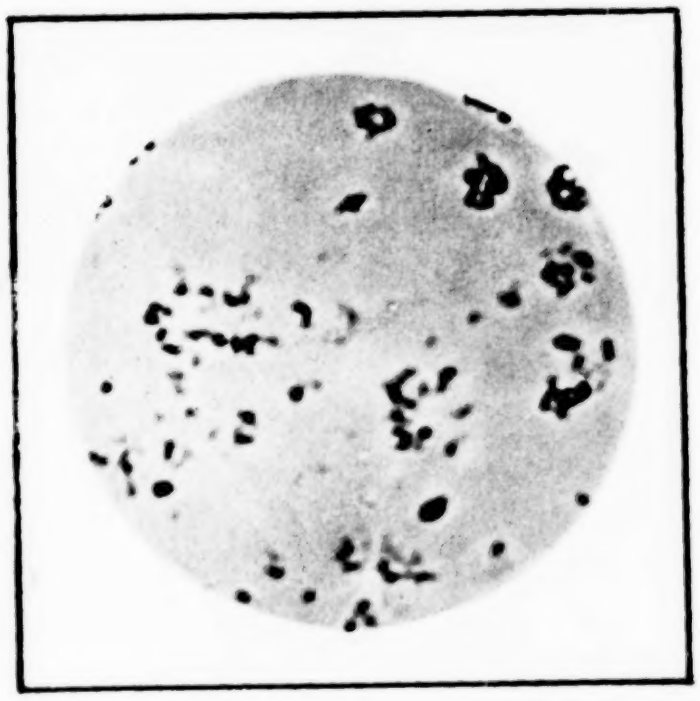

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Fig. 2.—A 100-c.c. sample of gas black—carbon particles—from alveolar air deposited in matrix, probably of mucus. × 40.

Fig. 3.—Sample same as in Figure 2. × 1120.

Fig. 4.—A 100-c.c. sample of ore dust from alveolar air after only five deep breaths. × 250.

Fig. 5.—Same sample as in Figure 4. × 1120.

Fig. 6.—A 100-c.c. sample of zinc oxide fume from alveolar air. × 250.

Fig. 7.—Same sample as in Figure 6. × 2500.

the forcible breathing engendered by the carbon dioxide. By coating the cover glass with some stainable protein, it may be possible to bring out the particles at high magnifications.

Figures 4 and 5, showing a 100-c.c. sample of ore dust from a subject who had taken but five deep breaths from a dusty atmosphere, give a microscopic mount in which the particles are too scattered. By concentrating these particles in the form of a circle or a shorter slot, a better preparation would have been obtained.

It will be seen from Figure 6 that the concentration of particles is high, and that a sample of about half the volume would have sufficed for counting or for determining particle size.

Conclusion

Alveolar dust can be sampled directly by using Owens' jet dust counter, Kotzé's konimeter, or Hill's dust counter, in conjunction with Haldane's alveolar air sampler.

Analyses of exhaled air justify the assumption that samples of true alveolar dust are obtained by this method.

A description of experiments in sampling alveolar dust is given, illustrated by photomicrographs.

The method possesses a broad field of usefulness in studying the actual particles reaching the lungs of persons engaged in dusty trades, and it is apparently adaptable for use in analyzing problems of bacterial inhalation in infected atmospheres.

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A STUDY OF BACK STRAINS*

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INTRODUCTION

AT THE Norton Company of Worcester, Mass., the practice is maintained of following up employees who have any physical defects which may have occurred either before they were hired by or while they are in the employ of the Company. These men are reexamined each year in order to find out what changes in the defects have occurred and how the men react to their particular work, and in order to arrange, if necessary, a transfer to work that they can do without injury. The examinations have brought out some interesting facts. One of the defects, which is, rather, a type of industrial accident, and one which has been studied and recorded, is back strain. This injury may become a serious problem both to the employer and to the employee in loss of time, payment of compensation, and turnover in labor.

A "back strain" accident, as the term is used in this paper, means that accident or injury which a workman may suffer while engaged in some kind of work such as lifting, pulling, or pushing. The employee gives a history of feeling a sudden pain in the back, generally in the lumbar region or at the sacro-iliac synchondrosis.

* Received for publication April 6, 1925.

This paper represents an analysis of the back strains occurring in the Norton Company from 1917 to 1924, inclusive.

LOST-TIME ACCIDENTS AND BACK STRAINS

A study of Table 1 shows that in the eight years recorded there was a total of 143 back strains and that in only three years did the percentage ratios of back strains to the number of accidents involving loss of time fall below 10 per cent. In one year alone it was 32 per cent. In 1924 while there was no time lost because of back strains, there were such injuries, but loss of time was avoided by treatment and change of work.

Out of the total of 143 back strains recorded, twelve, or 8 per cent., involved no lost time, and sixty-eight, or 47 per cent., received no compensation; on the other hand, there were only eight during the eight years who lost no time, received no compensation, and incurred no medical expense outside of the factory dispensary. During the period two men were so severely injured that they have never been able to return to factory work. In both of these cases a complicating spinal arthritis was the cause of the prolonged disability. The total time lost, 2,114 days, for the eight years

TABLE 1.—LOST-TIME ACCIDENTS AND BACK STRAINS AT THE NORTON COMPANY FOR THE EIGHT YEARS 1917 TO 1924, INC.

YEAR	AV. EMPLOYEES	TOTAL LOST-TIME ACCIDENTS	BACK STRAINS WITH LOST TIME			BACK STRAINS WITH COMPENSATION			BACK STRAINS WITHOUT COMPENSATION		BACK STRAINS WITH NO LOST TIME	TOTAL BACK STRAINS
			No.	%	Days Lost	No.	Days Lost	Amount Paid	No.	Days Lost	No.	No.
1917	3,770	368	39	11	454	14	348	$913.41	25	106	4	43
1918	3,275	233	21	9	225	8	161	184.90	13	64	1	22
1919	2,709	161	21	13	224	8	137	500.41	13	87	0	21
1920	3,255	204	19	9	466	14	453	1,088.88	5[1]	13	3[1]	22
1921	948	22	7	32	189	4	171	1,008.08	3	18	0	7
1922	1,392	60	10	17	193	6	163	871.56	4	30	1	11
1923	2,092	76	14	18	363	9	342	1,202.65	5[2]	21	3[2]	17
1924	1,757	5	0	0	0	0	0	0.00	0	0	0	0
Total.....	1,129	131	12	2,114	63	1,775	$5,769.89	68	339	12	143	

[1] One man left the Company's employ unable to return because of injury.

[2] One man left the Company's employ unable to return because of injury, and one retired.

TABLE 2.—RELATIONSHIP BETWEEN TIME OF YEAR AND PREVALENCE OF LOST-TIME ACCIDENTS AND BACK STRAINS

YEAR	LOST-TIME ACCIDENTS		BACK STRAINS	
	Month of Largest Number	Number	Month of Largest Number	Number
1917	June	47	May	9
1918	March	27	March	6
1919	March	28	March, August, October, November	3 each
1920	January	26	January and October	4 each
1921	January and May	5 each	March and May	2 each
1922	November	11	October	3
1923	August	16	August	4
1924	February	2	.....	...

equals 5.79 years' labor of one man. The longest period lost by any one man was in 1920, when a workman lost 182 days. The highest compensation paid any one man was $748.80. There were two cases in which over 100 days were lost by one individual. There were five others in which fifty days or over were lost, but the average was a little over fourteen days with an average compensation of $40.34 a man. The question as to whether any special

time of the year showed a greater prevalence of lost-time accidents and back strains can be answered in the negative (see Table 2).

Statistics of Twenty-Eight Cases of Back Strain

In order to learn more about these cases, all the men of whom we had records of definite back strains and who were still in the employ of the Company were called to the main hospital; a history was taken of each man and checked up with the record, and an examination was then made. The record includes the man's name, age, shop number and department, the history of the cause of the back strain, the date, number of days lost, last treatment, type of work, symptoms of pain, recurrence of strain, and present condition.

All abnormalities of the back are noted on inspection and any deviation from normal posture or any curvature is recorded. To aid in this a plumb bob is used. The line is fastened at the median line of the lower cervical spinous process with a strip of adhesive plaster, and the plumb bob is allowed to fall. The relation of the spinous processes of the vertebrae to the perpendicular line is noted and whether or not the line falls into the groove of the nates. This line is kept on the patient throughout the examination of the spine and is of great aid in noting the amount of motion of the spine.

After inspection the patient is put through a series of motions to test the mobility of the spine in all directions, and any limitation of motion is noted. The patient first bends forward, keeping the knees stiff and, if possible, touches the floor with the tips of his fingers. Coming back to an erect position, he leans as far backward as he can. He is then directed to lean to the right, letting his right hand fall as if to touch the floor. The same motion is repeated to the left. The upper portion of the body is then rotated, the patient leaning forward and describing a circle rolling the trunk to the right, back, left, and forward again. The legs and feet are next examined. In recording the results the terms normal and free are used when there is no abnormality noted and when there is no apparent limitation of motion. The plumb bob is of great help in measuring the lateral motion. When the patient leans to the right or left, the line normally crosses the middle of the spine of the scapula. Any limitation of motion may be measured by the angle between the median line of the spinous processes of the vertebrae and the plumb bob line as read on a protractor.

At the time these data were collected there were twenty-eight employees working for the Company who had a definite record of back strain. The examinations of these men, when recorded and tabulated, showed the following facts:

History

Nationality.—

Italian	9
Swedish	7
French	4
Finnish	2
American	2
Irish	2
German	1
Scotch	1

Age.—The oldest man was 72 years of age, and the two youngest were 21. The average age was 38 years.

Causes of Back Strain.—

Lifting	21
Shoveling	2
Pushing	1
Stooping over lathe	1
Kicking a sliding platform	1
Fall	1
Unknown	1

Of the 21 strains caused by lifting, 13 were caused by lifting heavy grinding wheels, 2 by lifting loaded cases, 2 by lifting timbers, 2 by lifting loaded trucks, 1 by lifting kegs of grinding material, and 1 by lifting a piece of machinery.

Time between Injury and Examination.—The time between the date of injury and this examination ranged from 5 months to 6 years and 9 months, the average time being 2 years and 2 months.

Days Lost.—The maximum number of days lost was 74, the minimum was 2, and the total was 464, making an average per man of about 16½ days lost.

Pain.—When questioned as to pain experienced since recovery from the injury, 22 men reported that there had been no pain, 3 had had some pain that had persisted more or less, and 3 had pain only occasionally.

Recurrence.—Twenty-one employees have had no further trouble since the first injury, 5 have had recurrences, 2 have had two recurrences, and 2 reported their chronic condition as unrelieved.

Present Condition (Subjective).—The present condition of 17 of the men examined was given as excellent, 9 as good, and of 2 who were still bothered by their back strain one wore a brace.

Examination

Inspection of the Spine.—The inspection of the spine showed that 20 of the men had spines that were apparently normal and erect without curvature. Of the remaining 8, 3 showed a left lateral curvature, 2 a right lateral curvature, and 2 were round-shouldered with an anterior curvature.

Motions.—The motions of the spine were examined while the patient bent in four directions—anteriorly, posteriorly, laterally to the right, and to the left—and while rotating. In the bending forward motion, 21 men had a normal range of bending and the spinal movements appeared to be free; in 1 man motion was reduced to 5 per cent. of normal, in 2 to 10 per cent., in 1 to 15 per cent., and in 1 to 30 per cent. Of the other 2 men, 1 could make the normal motion but stiffly and 1 could only do it slowly. In the posterior bending of the spine, 25 men were normal and free in motion, 1 was very poor and limited, 1 was reduced to 5 per cent. of normal motion, and 1 to 15 per cent.

Twenty-four men were found to have a normal and free right lateral motion; 2 were limited in motion to a point where the plumb line fell in a line one-third of the normal distance on the spinous process of the scapula; 2 were limited to a point where it fell at the inner edge of the scapula, and 1 showed some resistance to bending and evidenced muscular spasm. The motion to the left was found to be normal and free in 25 men; with 2 the plumb line dropped at the inner edge of the scapula, and with 1 at about one-third of the normal distance on the spinous process.

Twenty-five men could rotate the spine normally and freely; 1 had about 80 per cent. of rotary motion; 1 could rotate stiffly with about 50 per cent. of rotary motion; and 1 could not rotate at all.

The results of these examinations show that while there are those who, as a result of back strain, are unable to return to factory work, the number of such cases is small. The period of disability of those able to return to work averaged sixteen and one-half days, while the longest period of disability was seventy-four days. All these men were able to do regular work and the majority were working in the same departments that they were in before the injury.

Conclusions

The results of these examinations reveal the following facts:

1. Back strain is of importance to the industrial physician and surgeon because of its prevalence.

2. Back strain is of importance to the employer because of the time lost in production and the cost of compensation.

3. Although there are those who as a result of back strain are unable to return to factory work, the number of such cases is small.

4. Although back strain is frequently a disabling accident when it occurs, the disability is not, as a rule, permanent.

5. Practically all the men were able to do regular work again and the majority were working in the same departments that they were in before the injury. Prolonged and complete disability is in most cases due to some complicating disease of the spine.

RESEARCHES IN MENTAL HYGIENE IN INDUSTRY: PART V. PERSONNEL SCIENCE AND ADMINISTRATION FROM THE STANDPOINT OF A HYGIENIST*

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CONCEPTION AND SCOPE OF PERSONNEL SCIENCE AND ADMINISTRATION

THE term "personnel" has come in recent times to mean the working force of such organizations as industrial establishments, business concerns, and public services. "Personnel administration" has likewise come to designate the art of managing the working force; and "personnel science," that body of authentic information which has been obtained through research in this field.

Though the art of managing workers is an old institution—as old as business and industry themselves—it is of recent development as a specialized discipline. The science is younger still and has hardly outgrown its swaddling clothes.

As one surveys contemporary industrial and business practice, he will find in some of the organizations special departments whose duty it is to manage to a considerable extent the entire working force; while in others, he will find this function largely decentralized and vested in the several departments. At the present moment the trend is toward decentralization with retention of some of the centralized bureaus which have definitely proved their worth by experience.

Where some centralization is in evidence, special workers are assigned to this work. One meets them in the rôle of employment workers, of welfare workers, of industrial management executives, of office managers, of industrial psychologists, of industrial physicians and nurses, of mental hygienists, etc. Though their names are legion, their fundamental purpose is the same. Reduced to simplest terms, that purpose is the adjustment of the worker to his environment.

Although this aim is universally noted, it is seldom attained to the fullest degree possible. In many cases, personnel departments—using this term for all such departments howsoever designated—are scarcely more than embellished employment departments where practically no improvement over old methods of hiring, transferring, and firing has been effected.

While the viewpoint expressed here is held by many personnel workers as well as by many leading business men and industrialists, many of them conceive personnel administration as a

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device designed principally to make more money for the employer. Those who hold the latter opinion either possess a myopic conception of business and industry or do not realize the implications in the relationship these institutions have to society. Furthermore, they overlook a point which history makes quite plain—the fact that one cannot long stand as the arbiter between capital and labor if he is prejudiced in favor of the one or the other. In addition to this, they blind themselves to the obvious—the fact that in actual practice the personnel worker occupies a position between the worker and his employer, even though the personnel worker is generally paid by the latter. It is this phase of the situation, particularly, that causes one to feel that any art or science of personnel or of human relations in industry or business which is built upon the proposition that money-making for the employer is its chief goal must be doomed to failure in the long run. Man, especially in large groups, reacts somehow, probably intuitively, to injustice. Lincoln expressed this very well in the following words: "You can fool some of the people all of the time, and all of the people some of the time, but you cannot fool all of the people all the time." I believe that this is a basic fact of human behavior, and for this reason I cannot conceive of a permanent science or art of personnel being based almost exclusively upon a desire for money-making.

Despite this, one may question the ability of the personnel worker to remain neutral when the demands and desires of capital and labor run counter to one another. In my opinion, however, this is possible for he may employ as his guide a social criterion. When the personnel worker cannot find a solution or make an adjustment which will improve the lot of both employer and employee, or at least satisfy them both, he can fall back on the criterion of the greatest good for the community in which both live. This social aim is of prime importance and is in fact that which makes possible the building up of a permanent science and art of personnel. Moreover, this principle does not run counter to biologic laws, because in essence it implies compromise; and compromise is the great mechanism which makes our social organization possible. By "greatest good" of the community is not here meant any speculative system of community ethics, but a system of ethics developed through study of biologic laws and made existent by the use of the experimental method or of some modification of it.

Fundamental Principles

One may gain insight into the philosophy of personnel science and administration as here set forth from another standpoint. Assume from biologic considerations that the worker and his employer possess the same rights to exist, to enjoy life, to make money, and to possess property. (I believe that these rights are recognized in our present legal system.) Assume, too, that if these rights were exercised to their logical and ultimate conclusion, a society like ours could not exist. People have found it necessary, therefore, to allow the element of compromise to enter in, order to live together, and so in the case of property and

labor the mechanism of "bargaining" came in. In the "bargain" one traded with others, giving or receiving property or labor. As years went by the institution of the market grew up, surrounding bargaining with various rules of procedure, taboos, and limitations.

While this process has been going on another principle has been gradually crystallizing—a principle which in truth has only recently been recognized, namely, that in these relationships between man and man, between employer and employee, the health of the parties concerned ought not to be compromised. This may be more simply stated in the following words: Granting the mutual and equal right of bargaining between employer and employee, the health of either should not be injured, particularly if one or the other exists in large groups. Applying this principle to industrial relations is, of course, something relatively new, for industry itself is very young. (It may be stated here parenthetically that this contention does not necessarily favor state control or interference. The state should become involved only when private individuals or groups cannot themselves handle the situation in an efficient manner.)

Bearing these principles in mind, the personnel administrator or worker may be considered to occupy a unique place in our social and industrial system. Almost always engaged and paid by the employer, he is expected to stand, as it were, between the management and those employed. It is perhaps an illogical situation, maybe an impractical one, but among some of our best managed plants the personnel administrator is distinctly told not to pursue his work for the sole interests of the company by which he may be employed; that his being engaged by the company is a practical necessity but one which should not cause him to be prejudiced solely in favor of the employer.

In my opinion the position occupied by the personnel worker in industry is analogous in many ways to that of the health officer in our communities. The health officer stands between the enemies of his community and his people. In his case, the enemies are generally thought of in terms of disease or filth. In the case of the personnel worker, he stands not only in this relation but in that of protector of his charges from the ravages of social[1] disease. On this point, perhaps, one may feel that the personnel worker is more advanced than the health officer, because he not only considers physical disease but social and mental disease as well. This is not necessarily so, however, for in a number of enlightened communities our health officers consider all these dangers. This analogy still holds even when one raises the objection that the personnel worker is very rarely a physician, for today there are many communities in this country where the health officer is not medically trained. This objection, however, does one thing—it points out that the personnel administrator is in need of medical training, at least of an acquaintance with the biologic sciences and the biologic point of view. Whether or not this training will become general in the near future is a question. At least, however, the hope is stimulated that in years to

[1] "Social" in the broadest use of the word.

come something of this nature will be brought about. As Descartes has said, "We must look to Medicine for the solution of those problems which concern the greatest good and health of humanity."

Definition of Personnel Administration

Personnel science is an applied science which differs from pure science in that it has a purpose outside of science itself. This purpose, as previously expressed, is the adjustment of the worker to his environment, (and as the hygienist always insists) to the end that the happiness and welfare of our communities will be maintained and fostered, and that illness and misery will be prevented. Personnel administration is the art of accomplishing this end. As an applied science, personnel science employs the method of science, namely, observation and experiment. At the present time, it is poorly developed, but there are numbers of investigators who are working in this direction and in the next two or three decades considerable advance is predicted. As an art, personnel administration is inspired by and looks for help from the sciences of psychology, sociology, anthropology, economics, the medical sciences, etc., and from the arts of psychiatry, applied sociology, industrial psychology, scientific management, mental hygiene, and the like.

In the future, a large number of facts and relations will be brought into being through this science of personnel. That, in truth, which will be obtained is laws of behavior. With these laws of behavior an efficient and practical system of personnel administration will evolve which will ultimately deserve considerable confidence. Perhaps one cannot hope that the great precision which the physical sciences possess may be obtained in these laws of behavior, but a great advance over present information and methods can be safely predicted.

Functions of Personnel Administration

Having expressed my views as to personnel science and administration, I will pass on to a brief exposition of the more common and important functions of personnel administration as practised today. These are hiring, transfer, promotion, discharge, educational work, employees' service, health and safety work, wage incentives, and the like. It may make the meaning of the more important of these functions clearer if the reader follows with me the worker from the time he applies for work to the time he leaves the employ of the company.

The man is in need of a job. He has heard that there are some vacancies with a large company. He approaches the desk of the employment department and here he is met by some official who asks many questions and who finally tells him whether or not there is work available and whether or not he is suitable or desired for employment. If the applicant appears desirable, he is usually sent to a foreman of the department which is in need of workers and is interviewed by him. If he is satisfactory to the foreman, he is finally employed. Up to this point the more common method of hiring and placement has been described without going into details.

The employee's first initiation into

his new work varies, of course, from plant to plant, but essentially it is short and cursory. A few of the more important duties are pointed out and he is left to the mercy of chance and to his own abilities to become acquainted with the requirements of his job. If he is a skilled worker, this is not always a trying adjustment, but in the case of beginners and others it is very apt to be. Time goes on and our worker, if not already skilled, becomes so. Ordinarily he may be given a raise in wages at stated intervals or he may have to ask his foreman for a raise when he believes he deserves it. Sometimes the raise is granted and sometimes it is not. In many plants there is considerable routine to go through before wage raises are allowed. Outside of the question of wages, there are numerous other adjustments which our worker is compelled to make. He is forced to become a member of the factory organization, he needs to adjust himself to the various types of men about him, and he must become acquainted with the various customs and attitudes which are always found in large groups of people. During these various adjustments it is readily seen that opportunity for maladjustment offers itself easily, and in fact maladjustments occur frequently. These are generally taken care of by the foreman and in other cases by some executive attached to the personnel department. As time goes on, our worker may be transferred to other departments where there may be greater need for workers, or he may be promoted to a job requiring greater skill, having demonstrated his ability in a simpler one. It is impossible to picture here the thousands of adjustments that are constantly taking place in a factory or store. The point to be stressed, however, is that change in relationships is continually taking place, that our army of workers is constantly passing through a flux of changes, and that each worker is ever subjected to them. Granted that periods of business depression do not disturb his place in the organization for which he is working, he may remain until death takes him off; but the most common phenomenon observed is that of a worker passing on from company to company. This involves in each case the process of discharge or voluntary termination. In some of our companies an employee who signifies his intention to sever his connection is interviewed by a special personnel worker whose business it is to try to find out his reason for leaving and, if possible, to persuade him to remain.

In a considerable number of plants today there are hospitals with nurses and physicians who take care of accidents as they occur. In a much smaller number of plants, physical examinations are required of practically all employees before they are finally engaged. This is more true of factory than of store practice. An attempt is made to eliminate or to adjust the physically and mentally unfit and to pick out jobs which more nearly meet the physical and mental abilities of the employee. In some plants we see various attempts at employees' service, the purpose of which is to make the employee happier and better satisfied with his work. Rest rooms, restaurants, organized recreation, etc., are provided to accomplish this. In some we see evidences of preventive work, especially along the lines of

safety. Here there is an attempt to cut down the number of accidents both on account of the saving involved and on account of simply humane considerations. In a number of places there is an attempt to organize the management and the workers along representative lines into forms of self-government which allow both groups to have a free voice, at least for discussion. This picture, roughly sketched, represents, with few exceptions, the most common practice in personnel administration today. It is admittedly unscientific and almost intuitional in conception.

Need of a Scientific Attitude

One ought not, however, to be too critical of the efforts of the present-day personnel worker, for only recently has any attempt been made to develop the science. For this reason, if for no other, the personnel worker is justified in feeling that he must do the best he can under the circumstances to meet the daily problems of his job. Nevertheless, there is one thing the personnel administrator or worker immediately needs, and that is a scientific attitude of mind. At the present time he is very apt to be cocksure of his results and to feel positive of the value of his methods. With a scientific attitude of mind, he will not be so sure; he will be more apt to examine his results and methods in the light of impersonal criticism, he will arrange his department and the various procedures in such a way that it will be possible to make at some time a scientific evaluation. Unfortunately this is only exceptionally being done today. At any rate, the one great step that personnel administration in general should take is to gain this impartial attitude toward its methods and results.

Vocational Guidance and Selection

During the past ten or fifteen years several attempts have been made to control scientifically the selection and guidance of workers. This has been accomplished mainly by the construction and employment of psychologic tests. These are very often tests of so-called native intelligence, and in other cases, tests of special ability. Besides these, a number of so-called trade tests have been evolved.

Tests of native intelligence are devised to test what many psychologists believe exists as an inherited ability to learn. This whole subject is bound up at the present time in considerable controversy. One may, however, with good reason, believe that these tests measure what they are planned to measure, not knowing exactly what is being measured. Tests of special ability are supposed to test specific forms of ability which are practically unlearned and have somehow come to the individual through inheritance. This subject, too, is bound up in considerable controversy. Many claim that what these tests really measure is not unlearned special abilities, but abilities which through chance or through precocious development appear to exist to a greater degree than found in the average person. Trade tests are supposed to measure special abilities which have been learned through experience or through formal education. These were among the first and were fairly successful in the army during the World War. Since then their industrial application has not been widespread, chiefly be-

cause of their greater expense over older methods. Their precision, however, seems not to have been seriously questioned in any later attempt at their use.

Tests for native ability are either individual or group tests. In the army during the World War group intelligence tests were given to over a million men and some inferences were drawn which established with some degree of probability that various occupations tended to fall between certain levels of intelligence. Since then, similar tests have been devised for use in the scientific selection of workers. These have had some measure of success in a few occupations where abilities which tend to make people successful in school are required for success in their work. In other occupations these tests have not, as a rule, been successful.

A desire on the part of many psychologists to meet the demands of industrialists for a cheap and efficient test, one which could be given by the average clerk, certainly merits severe criticism. To my mind, this desire accounts in large part for the many failures that have come about in the use of intelligence tests in industry. It is now becoming apparent to psychologists, and has been conceded for some time by psychiatrists, that the value of psychologic tests decreases directly as the person who administers the test lacks special psychologic training. A psychologic test stands always in need of interpretation; and interpretation always depends on a large experience in the construction and in the administering of tests, as well as on a considerable grounding in theory. Besides this, it is becoming apparent that the ability to learn, that is, so-called native intelligence, is only one of the many traits which are necessary for success in business or industry. For this reason psychologic tests for selection possess not a positive but a negative value.

From the theoretical statistical point of view, a score obtained from giving an individual test is always liable to great error. This fact is recognized by psychologists when they give tests to large groups in order to obtain the relationship between two or more variables. They know that the error in their results varies inversely as the square of the number of individuals tested. But they forget this fact when they carry over inferences from the results of group tests to the results of an individual test. For this and the foregoing reasons psychologic tests of intelligence and of special abilities should be used with the greatest care and should be conceived in the light of offering only an extra bit of information. In my personal experience I have found that these tests have some use, but that they must be used with the greatest amount of care, must always be used with the foregoing considerations in mind, and must always be used in conjunction with evaluation of as many other traits as one can possibly observe.

Group intelligence tests are somewhat more dependable, especially when used for obtaining levels of intelligence for various jobs. My experience with special ability tests is limited, but my feeling is that they must always be used with the greatest amount of care and in conjunction with other data; they never should be used alone. As for trade tests, gen-

eral experience indicates that these can be used with less danger of error, and should deserve a greater place in the selection of workers.

Vocational guidance differs from vocational selection mainly in the end to be achieved. In vocational selection, the employer attempts to obtain a more able workman. In this case the choice is generally left to the employer. In vocational guidance,[2] the situation is somewhat altered; here there is an attempt to discover what abilities or lack of abilities are present in an individual so as to advise him what occupation or occupations to enter. At the present time the only important scientific advance in vocational guidance has been in the use of the same tests that are used for vocational selection. My chief criticism of the efforts of vocational guidance workers, and this applies with greater force to those who claim some scientific value for their work, is that they place unusual dependence on the use of psychologic tests, too little dependence on the evaluation of emotional and other personality traits, and hardly anything at all on physical characteristics. To my mind a truly scientific vocational guidance must be based on the assumption that every individual possesses at least three aspects: the physical, the mental, and the social. With this must also come a more elaborate and more definite knowledge of the various jobs to which it is intended to fit the individual.

[2] There is a school of vocational guidance workers which does not believe in giving positive advice; but, in my opinion, this attitude toward the problem can hardly be, nor is it consistently carried out in actual practice.

The Interview

Interviewing applicants for work is a very important procedure in personnel administration and one of which relatively little has been written. Apparently each personnel worker develops his own technic without any formal or organized attempt to see that this technic is based on the best practice available at the present time. It seems here, too, that a knowledge of psychiatric method would prove of great value. The recognition of the importance of physical, mental, and social factors in the life of an applicant would do more than any one thing to advance the efficiency of the interview. The interview is indispensable and to my mind will never be displaced by any other instrument of personnel administration.

It may be appropriate here to suggest that personnel workers would find it exceedingly valuable to attend outpatient clinics at psychopathic hospitals. This suggestion could be broadened, as the idea became more popular, by seeing to it that personnel workers came into more intimate contact with patients who visit these hospitals. The great advantage that this opens up lies in the fact that in the abnormal individual one has the best opportunity as yet to witness the evolution and the interplay of the various factors that go to make up human nature.

In a previous paragraph a passing reference to job analysis was made. Adequate job analysis is quite essential to a science of personnel. It should be done with the greatest care, always bearing in mind the *physiologic* and the *psychologic* aspects of man.

This care has not been commonly taken in the various job analyses which have come under my observation, and, unless it is, job analyses will not serve the purpose which they are fundamentally intended to serve—the adjustment of the worker to the job.

In a field of endeavor such as personnel administration the practical always possesses an appeal which is irresistible. The administrator is always pressed and asked for practical methods of solution. The economic considerations involved are likewise of great importance. New measures should not cost any more than the measures they are intended to supplant. Of course, exceptions to this may sometimes have to be made because of social or other factors involved. In view of this, a suggestion found in a paper by Campbell[3] was taken up because it stimulated the hope that it might prove very practical in the hands of a personnel administrator. The point noted was the use of individual production curves in the hygiene of the worker. Individual production curves are now quite commonly used in industry as a measure of the productivity of the worker. It was thought that if some use of these curves could be made, they would prove of great practical value. Common sense recognizes that it is impossible for a hygienist or a personnel worker to examine as routine a group of employees when there is no complaint being made by most of them as to any trouble. If production curves would prove efficient indicators of adjustment or maladjustment, they would prove to be a great help to hygienists or personnel workers. An opportunity to determine this question was taken advantage of, and an experience of two or three months showed that the idea was practical. It was found, however, that numerous difficulties had to be kept in mind before interpreting these curves; but in the main, the curves seemed to possess considerable value. Of course, it is admitted that no scientifically evolved data were obtained which could be utilized with precision, but at least a beginning was made, a deeper insight into the problem was effected, and the value of such a method if universally employed was demonstrated. It is impracticable to describe here in detail exactly what was accomplished in this investigation on curves and the reader is referred to my paper on the subject which will be published in THIS JOURNAL in the near future.

[3] Campbell, C. M.: Mental Factors in Industrial Hygiene. THIS JOUR., 1923–1924, *5*, 130.

Special Problems

Many questions are constantly arising which perplex the personnel administrator; for instance, the relationship between dissatisfaction with one's work and other factors, the problem of repetitive work, and the like. The literature of the past few years has emphasized the importance of these special problems, but very little has been done to increase the light for the personnel administrator. Very little has been done to define the importance and relations of the various personality factors which are present among our workers. For this reason an investigation of the personality of the worker and a development of a method of study were attempted. An anony-

mous questionnaire was finally drawn up which would give some light on this subject and at the same time satisfy the demands of inductive science. Unfortunately it was impossible to obtain a series large enough to make the results possess definite scientific value, but the series was large enough[4] so that the results possess considerable suggestive value. Experience with this questionnaire indicates that its anonymous use in the study of personality is practicable in industry and business. It is true that the questionnaire employed was not all-inclusive and that there were numerous deficiencies, but the investigation showed that if this instrument were more universally used our knowledge of personality factors would be increased. Two special problems were investigated: first, the relationship between vocational dissatisfaction and various other factors; and second, the prevalence and character of phantasy or daydreaming or reverie while at work.

In the case of the first problem, no definite relationship was found between economic factors and vocational dissatisfaction. The results seemed to indicate that fundamental personality traits determine a worker's attitude toward his job and that a fixed dissatisfaction is probably due more to fundamental personality factors than to elements in the job itself or surrounding it.

In the case of phantasy, or of daydreaming, or of reverie during work, it seemed that this tendency to allow one's mind to wander while at work is quite common, whether the work is of a repetitive nature or not. The particular occupations studied (in this case, clerical workers and salesmen) made no practical difference in its prevalence or its character, and whatever differences were observed seemed to be due probably to fundamental personality factors or special periods in a worker's life.

[4] There were over 500 questionnaires in the series.

Medical Clinics

In any scheme of organization of a personnel department, the medical clinic deserves an important place. The need of such a clinic is generally accepted today. It serves in the interest of first aid; it is an economic measure in view of workmen's compensation acts. Its use by employees tends to make it possible for many ambulatory cases of illness to remain at work, makes it possible to raise the general health of the working population and to disseminate health information. It is also being used in a few places in the examination of applicants for work not so much for the purpose of rejecting them but for the purpose of their better adjustment to jobs, taking into consideration physical assets and liabilities. The medical clinic possesses many unique advantages. The most successful ones are popular and frequented in large numbers. Practically all kinds of medical and surgical work are being done, and in a number of factories and stores psychiatric consultants have been employed. It has been my fortunate experience to have served as consultant in psychiatry to a number of store and factory health clinics. It is remarkable how many cases one meets in which mental factors are present to an important extent. There is also some valuable statistical evidence[5] which bears out this

[5] Elkind, H. B.: Mental Hygiene in Industry. THIS JOUR., 1924, *6*, 113.

statement. Recognition of the fact that this state of affairs exists will mean the greater employment of psychiatrically trained physicians and will tend to raise the general efficiency of the medical work. Psychiatrists have accomplished a good deal to save patients, their families, the store or factory, and the community much inconvenience and expense. Experience, too, has shown that the psychiatrist deserves a place as consultant to the employment department. Here behavior problems arise in the daily routine, many of which are beyond the training and experience of the average personnel worker. The few cases which have come to my attention have been considerably benefited personally; the management which referred the cases has also been benefited.

Conclusion

The personnel worker today stands at the threshold of a great awakening. This will come about as it becomes more commonly understood that laws of behavior are at the base of practically all the phenomena which are the consideration of personnel workers.

The personnel worker stands in a unique position. Industry is destined to grow. We are now in the throes of an industrial revolution which, with quickened pace, is changing our lives and our ways of living, our thoughts, and our attitudes toward life. Social problems are becoming more complex, but, at the same time, the desire to understand them is gaining greater and greater strength. The personnel worker must make his contribution to social advancement; he must stand as that part of industry whose duty it is to institute measures which will tend to minimize the undesirable effects of an industrial civilization. He must himself realize his social importance, his social significance, as well as his industrial value. He must realize that he is the health officer of his industrial group, and that the worker and the community in which they live are to a great degree affected by what he does.

THE STATISTICS, DEFINITION, AND CLINICAL ASPECTS OF THE OCCUPATIONAL AND INDUSTRIAL DERMATITIDES*

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INTRODUCTION

BY FAR the most frequent affections of the skin caused by occupational and industrial labor are the skin inflammations (dermatitides). By dermatitis (skin inflammation) we understand in its broadest sense the local reaction of the skin to any irritation—an inflammation. At least one cardinal symptom of the inflammation, therefore, must be present, namely, reddening. In many cases this symptom is present alone, with or without subjective phenomena, and *restitutio ad integrum* ensues with or without scaling. Usually, however, the reddening is soon followed by swelling, or edema, by the discharge of serum at the injured spot, and then by vesicular formation, partly macroscopic, partly microscopic, from which moisture arises. We distinguish four interrupted stages: reddening, swelling, vesicular formation, and scaling. If, following a slight irritation, one of these stages suddenly appears with a tendency to progress, even on removal of the irritation, the skin is then said to be idiosyncratic to the irritation. We speak of such a condition as a toxicoderma. If all four stages develop after a severe irritation from which the skin has become more or less sensitized, we then have before us an occupational dermatitis. This soon heals after removal of the irritation, without any tendency to spread. If after a less intense irritation there arises a dermatitis, with a tendency to peripheral extension, which continues to develop after removal of the irritation or with constantly occurring relapses, without tendency to heal, and especially if other parts of the skin distant from the spot of irritation are attacked, we have before us an artificial or occupational eczema. Here, however, an anaphylactic or allergic condition of the skin is present.

Eczema is the most frequent type of the occupational and industrial injuries of the skin; dermatitis is far more rarely observed, and toxicoderma most rarely of all. These correspond to the allergic, the normal, and the idiosyncratic constitutions of the skin.

STATISTICS OF OCCUPATIONAL DERMATOSES

Some of the more important statistics from the literature of occupational dermatoses and from my own figures are as follows:

Among 250 patients, the average number of new patients who annually

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pass through his skin clinic, Prosser White found in one year alone fifty-six cases of eczema from trinitrotoluene (T.N.T.) and also one case of pustular eczema caused by sodium sulphide. K. Herxheimer enumerates seventy-four industries which may cause eczema. The eczemas most particularly mentioned are those of metal workers, bakers, launderers, spinners, and carpenters. Detailed statistics by Frank Crozer Knowles contain 4,142 cases of eczema; of these more than one-fourth are positively of external origin. In a second list of statistics covering 24,459 skin cases, one-third of all the cases of eczema are industrial, and one-sixth of all cases of skin disease are caused by individual labor. Knowles finds the greater number of occupational eczemas among household workers; next in order appear laborers. From this he maintains the standpoint that practically every occupation and every irritation may cause an eczema. Among 187 cases of industrial eczema F. Gardiner found eleven cases of universal dermatitis; forty-two cases were complicated with seborrhea; and in twenty-three cases hyperhidrosis was present. Finch Noyes analyzed 5,000 skin cases and found among them fifty-four cases of dermatitis due to external causes, such as paint and lime. J. Sandberg examined fifty-five cases of dermatitis at his clinic and designates thirty-five as industrial eczema and fourteen as toxic dermatitis. According to Fordyce the industrial eczemas of the skin comprise 2 per cent. of the attendance at his clinic. The most frequent type is an eczematoid dermatitis, the appearance of which is favored by the excessive use of soap and water.

From statistics compiled by Eisner in the skin clinic at Frankfort, in 1913, we learn that fifty-six industrial eczemas were observed that were caused by chemicals, and five caused by thermic influence. Meltzer reports on the frequency of quinine toxicoderma. In the prophylactic administering of quinine 0.12 per cent. of the persons got exanthemata, army officers particularly. From this the author concludes that nervousness creates a predisposition. We see from these examples that idiosyncrasy is extremely rare. The absence of idiosyncrasy was also observed by McLachlan and D. Allison who found among 200 metal cutters only seven affected with eczema on the hands and forearms, from the effects of lubricating oil and inunctions.

That certain substances, particularly those contained in explosives, may cause dermatitis in many persons is proved, not only by the statistics mentioned above taken from the cases of Prosser White, but also by the statistics of Sequeira, in which he enumerates fifty-one cases of dermatitis called forth by aerial bomb explosions which he traces to hexanitrodiphenylamine.

A second list of statistics by Gardiner is more detailed. In the year 1919 he found 1,194 cases of dermatitides. Of these, 870, or 72 per cent., were professional dermatitides. Housewives and women servants suffered most (254 cases), then general workers (59 cases), and, finally, those in the chemical industry (25 cases). Gardiner finds the most important

predisposing factors to be seborrhea, hyperhidrosis, and pediculosis.

Some of my first statistics, in 1912, which comprised 3,040 cases of skin and sexual affections, after deduction of 1,000 of the latter, gave 457 persons who were suffering from occupational and industrial skin affections. Among them were 153 cases of eczema and artificial dermatitis, and two cases of artificial exanthema—namely, purely toxic skin inflammations; this represents 34 per cent. About one-third of all occupational and industrial skin injuries, therefore, are eczemas and dermatitides; the toxic skin inflammations are almost negligible. The exact relation of the dermatoses to one another is shown in Table 1. The distribution among the various vocations is shown in the following tabulation:

Vocation (Men)	*Number*
House painters and varnishers 12, lithographers 3, dyers 3	18
Bakers 29, gardeners 3, drivers 6	38
Bookprinters 9, mechanics 15, metal workers 2	26
Turners 7, casters 56, machine workers 7	70
Coopers 2, carpenters 28, pianomakers 2	32
Fine-metal smiths 9, saddlers 4, coppersmiths 2	15
Jewelers 3, comb-makers 2, grinders 2	7
Plumbers 2, locksmiths 32, blacksmiths 4	38
Tailors 4, shoemakers 3, weavers 2	9
Cork-stone workers 2, stone cutters 3, zinc platers 2	7
Laborers in other occupations	118
Vocation (Women)	
Bookbinders, gold burnishers, makers of cigarette paper	8
Laborers in various vocations	35
Total	421

My statistics for the year 1910 (Dispensary of the Union of Sick Funds Societies) comprised 604 cases of occupational and industrial skin affection; among them 188, or 31 per cent., were cases of dermatitis and eczema. These types, therefore, again constituted one-third of all industrial dermatoses. The total number of cases, grouped according to their diagnoses, are given in Table 2.

TABLE 1.—ANALYSIS OF 457 CASES OF OCCUPATIONAL AND INDUSTRIAL SKIN AFFECTION ACCORDING TO TYPE OF AFFECTION

TYPE OF AFFECTION	MEN	WOMEN	TOTAL
Eczema and artificial dermatitis	119	34	153
Combustions and cauterizations	239	15	254
Fissures and callosities	21	1	22
Chilblains	10	2	12
Herpes tonsurans, erysipeloid	4	..	4
Oil acne, tar skin	9	1	10
Toxicoderma (erythema)	2	..	2
Totals	404	53	457

TABLE 2.—ANALYSIS OF 604 CASES OF OCCUPATIONAL AND INDUSTRIAL SKIN AFFECTION (1910) ACCORDING TO TYPE OF AFFECTION

TYPE OF AFFECTION	NUMBER
Eczema and artificial dermatitis	188
Combustions and cauterizations	229
Fissures and callosities	29
Hyperhidrosis	30
Impetigo in connection with vocation	128
Total	604

These small statistics of mine show that the industrial eczemas comprise

one-third of all industrial dermatoses and about 8 per cent. of all skin affections. Prosser White places more than one-fourth of his skin diseases among the industrial eczemas; Crozer Knowles gives the same figure in his first list of statistics, and in his second, longer list he gives even one-third of all eczemas and one-sixth of all skin diseases as occasioned by industrial work. Finch Noyes, however, finds that only 1 per cent. are industrial eczemas. These differences naturally vary with local conditions. Clinics in the neighborhood of large chemical factories will, of course, show a much larger proportion of occupational dermatoses than those situated in agricultural, nontextile, and purely commercial districts.

My full statistics embrace the years 1907 to 1922, inclusive (fifteen years), excepting the records for the years 1911 and 1917 which are missing. The figures are taken from the Dispensary of the Union of the Sick Funds Societies in the Tenth District of Vienna which was conducted by me until the year 1917 and then by my successor, Dr. Neugebauer, in the Eighth District. They comprise 41,200 cases of skin and venereal diseases; among them were 5,334 cases of toxicoderma, dermatitides, and eczema—about 13 per cent. Deduct one-third of the total number as suffering from sexual affections, and that leaves approximately 27,500 skin cases of all kinds; then the 5,334 cases of skin inflammations will represent about 20 per cent. One-fifth of all my skin diseases are, accordingly, industrial eczema. The relations of eczema, dermatitis, and erythema are shown in Table 3, which embraces the years 1907, 1908, 1909, and 1910. From this table it appears that eczema is sixteen times more frequent than dermatitis and twelve times more frequent than toxicoderma. If we consider that many of the cases of dermatitis and toxicoderma became eczema, which the records do not differentiate, the exceeding frequency of the occupational and industrial eczemas is also well shown by this table.

TABLE 3.—INCIDENCE OF ECZEMA, DERMATITIS, AND TOXICODERMA IN THE TENTH DISTRICT OF VIENNA, 1907, 1908, 1909, AND 1910

YEAR	NUMBER OF PATIENTS	ECZEMA	DERMATITIS	TOXICODERMA
1907	1,679	383	10	28
1908	2,433	324	15	30
1909	2,800	351	30	24
1910	2,784	286	29	30
Totals..	9,696	1,344	84	112

Definition

In my thesis up to now, I have separated occupational and industrial toxicodermas from industrial eczema, although, of course, the cause of an industrial eczema may lie in a toxicoderma. I would, however, further distinguish a third group of dermatoses of occupational and industrial causation, namely, artificial dermatitis. All three rest on an allergy of the skin in general. This proceeds from the circumstance that always some individual persons suffer from inflammations of the skin only when strongly irritating substances or processes are the responsible agents. This, for instance, corresponds to Stammler's

definition in which he explains the inflammation as "a local reaction to irritations to which the organism is not at all, or not sufficiently adapted." The allergy of the skin may be congenital—we then call it idiosyncrasy or congenital hypersensitiveness; or acquired, due to some anaphylactic process—that is, "a skin sensitization, due to the excess or deficiency of something found in a normal or ordinary skin."

Into these questions we do not propose to enter, except in so far as they help us in the clinical understanding of dermatitis. At the last Congress of the German Dermatological Society in Munich, the question of eczema was made the main subject of discussion. The debates did not, however, fully clear up the matter. Most of the authors interpreted eczema as a hypersensitive reaction, and distinguished neurodermatitis from eczema; on the other hand, they identified it with dermatitis and considered that the irritation first attacked the epidermal cell.

Kreibich occupies quite a unique position in regard to the interpretation of eczema. He interprets it as a vasomotor reflex neurosis and, according to him, the sensory nerves of the epidermis are primarily irritated and lead to a reacting inflammation of the cutis. Different degrees of irritation and mutual relations between sensory and vasomotor excitement cause the various eczemas. Of these he distinguishes two fundamental forms: the *neurodermatitis exudativa eczematosa*, in which the itching is primary and the scratching the cause of the cutaneous changes; and the *dermatitis eczematosa*, in which the epithelial nerve has a congenital or acquired hypersensitiveness and the vessels are labile. The irritation may, of course, strike the epithelial nerve from without, or from within, and produces dot-shaped vasomotor changes, in contrast to the erythemas where the point of attack must be assumed to be in the subpapillary vascular network.

Bloch takes another standpoint. He demonstrates experimentally in the skin of eczematous persons the presence of a hypersensitiveness to certain chemical substances, which may be monovalent or polyvalent. The cause of the eczema consists in a congenital hypersensitiveness, or an acquired sensitization of the epidermal cells to certain chemical substances. He therefore regards eczema as an anaphylactic condition of the skin. Two chief factors come into consideration as the cause of the eczema: the predisposing factor, which may be congenital or acquired; and the exciting factor, that is, the coming into contact of the skin with the substance to which the sensitiveness responds. These conclusions by Bloch are based on the experiments of his pupil Jaeger, who has established this specific skin sensitiveness to certain chemical irritations by a kind of skin function test.

Jadassohn agrees with Bloch's views. Riecke also assumes a skin hypersensitiveness and identifies dermatitis with eczema. He pictures both as pure inflammations but says that they are influenced by a higher and specially colored pathologic factor—either an organic disposition, or a general diathesis. In contrast to Kreibich, he distinguishes neurodermatitis from eczema. Pinkus also interprets eczema as a hypersensitive reaction responding

to external agents and vaccines. Therapeutically the latter may be useful. As long as inflammation remains, a latent general affection exists.

Like Riecke, Finger identifies dermatitis with artificial eczema and distinguishes a general and a special predisposition; in the former every person's skin reacts to inflammation, in the latter only a small number of individuals respond to the stimulus. Blaschko distinguishes the toxic skin inflammations from the industrial eczemas and gives as the difference between them the sudden rise in the former and the gradual development in the latter, which he defines as a dermatitis taking a subacute or chronic course. Its most important subjective symptom is the itching, and its most essential objective symptom is the formation of vesicles. Even in dry eczema these may be demonstrated microscopically.

I absolutely adhere to the separation of artificial dermatitis from eczema. Many authors, however, consider that they are identical. It must be borne in mind that every eczema is a dermatitis, but not *vice versa*. As I have already mentioned, dermatitis is the broader conception. It embraces not only the eczemas, but the toxicodermas also. The identity of both is upheld by Wolf, who from the histologic standpoint asserts the impossibility of drawing a sharp distinction between dermatitis and eczema. Frank Crozer Knowles finds distinction neither in histologic nor in etiologic aspects, but only in the duration. He calls skin inflammations of short duration dermatitis, and those of longer duration eczema. Hartzell, Jackson, Volk, Hammer, and others likewise find no essential differences.

Unna, on the contrary, points out two symptoms as characteristic of eczema which never appear in artificial dermatitis, namely, acanthosis and abnormal fat secretion. Ravogli, likewise, draws a sharp boundary line between eczema and dermatitis; the latter, he says, is an acute affection, and the former begins when the other ceases to be acute. In eczema, infiltration exists—infiltration associated with papules and vesicles with a tendency to a chronic course. This differs completely from acute dermatitis. In the former we may probably presuppose a disturbance which always changes the skin.

Montesano divides the occupational skin inflammations into several categories and distinguishes among them those which manifest a tendency to spread on the surface and at the same time to assume the characteristics of eczema. These are the commonest group. Rost combines under the collective name of dermatitis all defensive, reparative, regenerative, in fact all reactive processes of the skin, and therefore sub-summarizes eczema under the further conception of a dermatitis.

In the toxic skin inflammations we have to deal with congenital hypersensitiveness, which in its effects may vary from a simple temporary reddening to the severest bullous eruptions of the entire cutaneous surface, and may even result in death. The smallest quantity of the toxic substance suffices to produce toxicoderma.

Artificial dermatitis is quite different. Here the principal thing is the

external irritant—the severity, the duration of effect, and the extent of surface are the prime factors. When the irritation is removed, the dermatitis heals. The skin is very little or not at all sensitized. Normal persons suffer from artificial dermatitis, although in different degree. Most skins are neither monovalently nor polyvalently sensitive to chemical substances (Jaeger). Mustard plaster, for example, mostly calls forth erythema, cantharides cause bullous dermatitides, volatile unguentum and tartarus stibiatus salve produce severe pustulous dermatitides, etc. Sometimes it is the intensity of the irritation which produces the dermatitis; sometimes it is the duration of its action which leads to the intense effect. We can accordingly define artificial dermatitis as "a skin inflammation set up by irritation on a normally reacting skin or one which is but little sensitive."

In artificial eczema the irritation has struck a sensitized skin. We are here dealing not with a local affection, but with an affection of the organ of the skin. Trifling irritations, therefore, are able to call forth skin reactions. For the same reason only a small number of persons fall ill of eczema, the inflammation persists after the irritation has ceased, it tends to spread peripherally in the circumference of the irritation, other symmetrically situated portions of the skin become affected, and newly affected areas arise far distant from the primary lesion on the smallest aggravation, such as slight scratching. An artificial eczema is difficult to heal and tends to recur. Sensitization may also be induced by existing skin affections, and the beginning of an artificial eczema is often a toxicoderma or an artificial dermatitis. Either of these affections, by forming toxins which reach the circulation (Nathan and Sachs), may make the skin anaphylactic. By experiments on the skin of guinea-pigs Nathan and Sachs found that in the inflamed portions substances could be extracted which contained the irritants of inflammation. They consider these particularly important in explaining an eczema following a dermatitis and deciding the cause of the scaling.

External irritants produce at first hyperemia and edema, inflammatory products are absorbed, and pain and rubbing provoke new areas far distant from the original inflammatory area in parts within the region of the collateral edema. The points first implicated are thought by Kreibich to be the epithelial nerves, by other authors the blood vessels; most writers, such as Jadassohn, Bloch, Jaeger, and Gougerot, favor the epithelium. The last named assumes a certain porosity of the epidermis which can be penetrated by toxic substances.

With regard to the sensitization of the skin, briefly we must distinguish a general susceptibility which makes the skin sensitive to all irritations, and a special susceptibility confined only to certain substances (Jadassohn). In reference to the latter I will mention the observations of Jacquet and Jourdanet regarding gastro-intestinal disturbances as a cause, and, further, those of W. Knowsley Sibley, who sees predisposing causes in the condition of the intestinal tract as well as in the use of tobacco and in the taking of tea, coffee, cocoa, and alcohol.

Ehrmann likewise finds disturbances of digestion to be sensitizing. Luithlen and Weidenfeld also believe in the general sensitization of the skin. Pinkus interprets any latent, general affection as a cause of sensitization. Localized special sensitization is observed in odol eczema. A generalized form is distinguished by Jadassohn. Here we have to deal principally with anaphylactic conditions.

To me the sensitization of the skin by existing skin affections seems most important. Not only do toxicodermas and dermatitides sensitize the entire cutaneous surface but many other skin affections also do this. I will only mention here the influence on artificial dermatitides of seborrhea and ichthyosis (Riehl); the development of obstinate eczemas after impetigo simplex and sycosis; the prolonged eczemas in cases of prostatitis; the chronic eczemas on the palms and fingers of syphilitics. From these there results a vicious circle for artificial and idiopathic eczema. The one sensitizes the other, and therapy is hereby made more difficult.

Clinical Aspects of Artificial Dermatitis in its Broader Sense

By this title is meant the clinical phenomena of toxicodermas, of artificial dermatitis in its more restricted sense, and of industrial eczema. These three forms of occupational or industrial skin inflammations have an outward cause which lies in the occupation or trade concerned. The skin is injured either from without or, more rarely, from within. These three forms may pass one into the other and in their acute stage exhibit the same symptoms; they will be treated together. Industrial eczema, which is the most important and which, because of its symptoms, merits a particular place, will be described later.

Incubation Time

The skin phenomena appear, as a rule, only after a definite time. Subjective symptoms, such as itching or burning, may precede or accompany the first skin phenomena, or the subjective sensations may be felt only after the skin symptoms have become visible. Skin affections from the bites of animals, or from their hair—causing itching, burning, etc.—usually develop at once, and the skin phenomena follow soon after. The same is true with irritations called forth by the sap or gland-hairs of plants.

In the case of chemical substances the incubation period is usually longer. Thus, after touching the blossoms and twigs of the Singapore mahogany, reddening and swelling arise a few hours later (Ridley); after work on the rungus tree, native to Borneo, a papular eruption accompanied by intense itching develops after a latent period of twenty-four hours and leads to the formation of vesicles (Hornsey). In primrose dermatitis E. Rost found an incubation time of from several hours to sixteen days. Kanngiesser observed the first symptom of primrose dermatitis the day the plant had been touched. A. E. Stein, after touching sublimate, observed on himself that a mercury eczema took four days to develop. On the application of agfa, a remedy used to skin over an ulcer on the thigh, O. Sachs observed an incubation time of five days before the appearance of reddening and swelling. Widal, Abrami, and Jol-

train say that fourteen days is the incubation time for emetine powder, MacKee established two months for cocobolo wood dermatitis, and Gougerot and Blamoutier even two years in a laborer who had been working on palisander wood; the man interrupted his work for fourteen days and then resumed it.

The incubation time for skin changes from poisonous gases, such as were employed in the war, is very short; cyclon vapors (a prussic acid preparation which serves for the destruction of bedbugs) also very rapidly cause skin irritation (Flury and Wieland, Seligmann, and others).

In general it may be said that substances which act on the skin in the form of dust or vapor have a shorter incubation time than those in liquid or solid form. In laborers who work amid dust, heat, and wet, a longer time usually elapses before a dermatitis appears.

Localization

The toxic skin inflammations are either localized or general. Like dermatitis and eczema, the localized inflammations are seen on the parts of the skin coming into direct contact with the toxic substance, such as on the hands, forearms, face, neck, etc.; or they appear on parts of the skin where the toxic and medicinal exanthemata are usually found, as on the extensor surfaces of the extremities, the face, the genitals, or on parts of the skin which lie in folds or rub each other. When general, the inflammations cover the entire body without predilection as an erythrodermia, as an exfoliative dermatitis, or as an universal exanthema. While dermatitis and artificial eczema are confined to the point of attack of the irritant, or at least show the tendency to remain so confined, the toxic skin inflammations of an artificial nature have a tendency to be generally diffused. On the whole it may be said that the hands and then the face are the preferred parts of the skin for all artificial skin inflammations. Under special circumstances any other parts of the skin may participate. Thus the dermatitis which is caused by the leather lining of men's hats is strictly localized to the forehead and is cut off sharply at a horizontal line across the forehead (Galewsky, Bettmann, Appel, Froboese, Oppenheim, Sachs, and many others). By leaning the face on the art leather of railway cushions, dermatitides arise on the side of the face concerned (Gebert); a similar dermatitis of the face originated from the use of a mustache bandage (Baer). In all dermatitides coming from leather substitutes, phenol-containing substances are the cause.

In match box dermatitis it is the part of the upper thigh corresponding to the site of the trousers pocket containing the box where the dermatitis is localized (Rasch, Christiansen and Strandberg, Frei, Lomholt, and others). The eczemas of musicians are localized on the lips and their locality; in flute players they are caused by the resinous contents of the mouthpiece which is made of granadilla wood (Stein); violinists have eczemas in the region of the lower jaw; trumpeters have eczemas on the lips (Graetzer). Posner reports a case of dermatitis on the feet and lower thighs in visitors to a bathing establishment, the floor of which had been recently

painted with carbolineum. Spillmann mentions a skin inflammation on the right side of the face and in the region of the ear in a man who had been carrying oak logs.

The dermatitis called forth by the employment of cyanide of sodium we find is localized on the genitals and on the seat (McEwen); in trinitrotoluene dermatitis, likewise, the scrotum and nates are affected, and also the hands, arms, neck, abdomen, and toes (Prosser White); in the parts permeated with cyclon gas we find edematous swellings chiefly on the genitals, also eruptions where the sweat glands predominate (Seligmann). Riecke demonstrates a case with a threefold enlargement of the scrotum and acute generalized dermatitis on the trunk and over the greater portion of the extremities, caused by Peruvian balsam applied for scabies. Winfield reports a dermatitis of the scrotum and finger nails in laborers employed in paint factories; in men at work on reeds, the dermatitis appears on the scrotum, also on the face and the throat, and on the back of the hand (Timpano); workmen in dye factories are attacked by dermatitis due to arsenic on the scrotum and on the hands (Pusey). Lewenstern reports edema on the skin of the face, while the hands remain free, in a woman 60 years of age who exhibited such a skin eruption whenever she handled a red material at her trade as a dressmaker. In another case, both forearms and, to a lesser degree, the face of a packer became affected when reloading dried figs (O'Donovan). The case reported by Kleeberg will serve as an example of universal dermatitis proceeding from the fingers after handling sealing wax; and the cases reported by Gaucher, Gougerot, and Meaux Saint-Marc may be cited as examples of localized inflammations of the face and eyelids after taking 1 gm. of quinine. Carlo Vignolo-Lutati describes intertriginous localizations between the fingers in rubber workers, and J. A. Turner in laborers who have to deal with zinc oxide. The fingers are exclusively affected when employing formalin solutions (Galewsky) and in those who work with mesothorium (Lesser). This will suffice as to localization in general; in the discussion of the clinical phenomena we shall refer to other types of localization.

Clinical Phenomena

Erythema.—The artificial skin inflammations begin, as a rule, with an active hyperemia of the papillary vessels and the precapillaries; this manifests itself on the skin as reddening (erythema), which completely disappears on pressure with the finger and quickly returns after removal of the finger. The reddened part of the skin shows a local, raised temperature; Blaschko states that the decrease from the center to the circumference is characteristic of erythema. The erythema may begin with increased vascularization which spreads peripherally from the spot influenced (J. T. Cash, satinwood dermatitis). This may be similar to scarlatina and cover the whole body. Thus J. Douglas Blackwood describes a scarlatiniform erythema which spread over the entire body after turpentine. Mercury, phenol, and arsenic erythemas usually resemble scarlatina (Burnand, Blaschko, Becker, Brayton, Burnier, Almquist, Oppenheim, Harding,

Angus, French, Weyl, and others). Iodine may also produce a scarlatiniform erythema; Mossé, for instance, reports a case in which after fumigation with iodine an erythema appeared and spread over the whole body. Similarly, satinwood and other heavy woods may produce erythemas (Franck).

Morbilliform erythemas are caused chiefly by ethereal and balsamic oils and even other dry plant products. They also appear from chemical substances. Thus Prosser White reports an irregularly defined superficial erythema consisting of spots of about the size of a silver crown after trinitrotoluene.

Mesh-like erythemas are comparatively rare. Szuethoff describes a network-like exanthema on the forearms of a locomotive engineer caused by gas water. Habermann sees in mesh-like erythemas the beginning of war melanosis called forth by photodynamic substances, particularly by acridine. Paul H. Unna describes mesh-like, confluent spots and red dots on the lower arm, on the thigh, and on the temple as the beginning of a lubricating oil dermatitis.

Pale erythemas which only later become bright red are described by G. Goldschmidt as appearing on the skin of the hands, of the forearms, of the face, and of the eyelids after work with substitutes for lubricating oils; and Prosser White mentions a dermatitis which begins with a pale erythema after nitrate of ammonia at a temperature of 42° C. Radio dermatitis likewise begins with a light but demonstrable erythema (Rominger). Everett S. Lain describes an indistinctly defined erythema in gardeners, produced by the effect of saponin; this also occurs in tramps, who come into contact with plants such as Lycopersicum esculentum (tomatoes) in the early morning hours while still moist from dew.

Pellagra-like erythemas which often accompany, or initiate, the war melanoses are traced to photodynamic, light-sensitizing substances (Habermann); they may be caused by toxic substances from without. Wollenberg observes a reddish blue erythema from mesothorium. The acute, diffuse erythemas after gas poisoning, such as were frequently observed during the war, exhibit nothing that is characteristic. After a disaster from a mine explosion, eighteen of the rescued who had lain in the afterdamp for twenty hours exhibited acute erythema (Davis). The war gases cause erythemas which do not remain as such, but later pass into severe dermatitides (Heitzmann, von den Velden, Weber, Flury, and Wieland). Colored erythemas are caused by tetryl (Lucy Cripps) and dinitrochlorobenzol (M. J. Bernstein).

The erysipelas-like form of erythema is the one most frequently observed. It is marked by an acute, bright-red color and by sharply curved borders; a slight swelling may be present, or altogether absent. Its favorite localization is on the face, and especially the eyelids, but the hands, forearms, and scrotum often suffer. This form is distinguished from genuine erysipelas by the absence of any peripheral raised border and of fever, and by its rapid spread. Severe itching also constitutes a differential diagnosis as compared with genuine erysipelas. Primrose dermatitis

closely resembles erysipelas (Rost, Richet, Nestler, Waldo, Whitfield, and others). Erysipelas-like rashes are also caused by contact with the dust or juices of certain kinds of wood; for example, the Australian moe wood (E. Franck). The sap of Rhus toxicodendron (Bühler), also, causes the skin to assume a brilliant red, purplish coloring (J. B. McNair). The sap of the cashew-nut (*Anacardium occidentale*) produces a similar effect (Howard Fox), as does also the East Indian satinwood (*Chloroxylon swietania*) (Wiener, John). The mango tree (J. Simmons, Z. E. Bolin, Sund), the Heracleum giganteum (Ch. R. Straton), and the native box tree (Oppenheim) excite the same type of eruption. Erysipelas-like skin inflammations are rarely found after contact with chemical substances. P. Constantini, however, records them after painting with iodine.

Beside the erythemas, purpura simplex and purpura hemorrhagica are occasionally seen. They are local when due to chrome (Bunch); or generally diffused after the inhalation of benzol vapors (Flandin and Roberti, Weyl), after taking quinine (Gundram), or after irritation from asparagus juice (Brenning). Occupational erythemas rarely become hemorrhagic. They retrogress when paling, with or without scaling, either in the form of a bran-like desquamation, for instance after roentgen erythemas (Schlichting), or in large lamellae, in the latter case ending as erythrodermia exfoliativa.

Mercury is usually followed by fine scaling, and arsenical erythema commonly by large lamellae (E. G. French) (salvarsan erythemas). After turpentine, desquamation may be present (J. Douglas Blackwood) or absent (Angus); no rule can be stated. In the universal erythemas (erythrodermias) vesicles or exudations are rarely seen, but in the common occupational and industrial erythemas these further symptoms form the completed picture of the dermatitis and the eczema.

Edema.—Edema is the second stage in the artificial production of the toxicodermas, dermatitides, and eczemas. It appears locally or generally—either as a diffused edema, or as wheals and papules disseminated over the whole body. It may be either pale, anemic, or, and this is most frequently the case, in combination with erythema. The most usual localization of the toxicodermas is on the face, on the back of the hand, and on the genitals; on the face it is the eyelids and on the genitals the scrotum which show the greatest changes. In dermatitis and in eczema it is hardly ever so fully developed as in the idiosyncratic toxicodermas. The edemas may be very transient, as McNair states in that from Rhus toxicodendron; or they may be persistent, as in the incipient melanoderma called forth by arsenic, lubricating oil, pitch, etc.—substances said to make the skin sensitive to light (Brezina, Koelsch). Edema is followed by oozing, which mostly disappears with wrinkling of the skin or scaling.

A pale edematous skin is seen after injuries from strong electric currents, reported by Kawamura in two out of 110 cases. A dark-colored edema appears after dinitrochlorobenzol (M. J. Bernstein) and after tetryl (E. Smith, Prosser White).

Erythematous edemas are seen after all organic and inorganic substances which irritate the skin. Thus, plants and their products produce red edemas. Soyer reports it after ivy, Howard Fox after cashew-nut with particularly severe edema of the eyelids, Cash after satinwood, and John after teakwood. Among metals mercury in particular produces edematous swellings (Almquist, Oppenheim, and others). Mercury, especially, according to Oppenheim, causes severe erythematous edemas among ammunition workers; arsenic has a like effect (Nördlinger, Cazaneuve, Pusey, Ormsby, Winfield, and others). Impure aniline dyes cause red edemas of the face, hands, and scrotum (Blaschko, Sachs, Focke). These edemas are particularly extensive when the aniline dyes are employed to dye the hair. (Kingsbury records severe edema of the ears and eyelids and a light papular eruption on the head and forearms after use of a hair dye.)

Intense edemas also arise in susceptible persons after inhaling the most varied gases and vapors. Thus Leymann reports an erythematous edema of the face after tar vapors; Flury, Wieland, Heitzmann, and others record edemas after war gases; Druelle, Sequeira, MacLeod, Tyson, and others after explosive gases proceeding from bombs; Bruhns after chlorine gas. The acute inflammatory edemas which are caused by the petroleum and tar group are also extremely severe. They concern the face and hands chiefly, correspond to the pellagra edemas, and are probably caused by photodynamic substances which sensitize the skin to the light (Koelsch). Ullmann traces the diffuse inflammation phenomena of this group rather to the volatile carbohydrate substances. The edemas which appear after poisoning from illuminating gas are more localized (Weyl, Fischl).

With regard to urticarious and papular eruptions, all grades appear from the most tiny, dot-shaped nodules up to the giant urticaria and giant papules. The color of the efflorescence may show all transitions from yellow to dark, bluish red; their consistency may be soft, coarse, or very coarse. They usually become pale on finger pressure; their surface may be normal, or they may scale in the most varied way. Sometimes transitions to the formation of vesicles are already visible on their summits. They show for the most part a tendency to run together or to lichen formation; sometimes they retrogress, with or without scaling; sometimes they unite into scaling or nonscaling plaques. The rash may be limited to the spot irritated, or it may extend to the extensor surfaces of the extremities, to the face, or to folds of the skin which touch each other; sometimes the entire body is affected.

Pruriginous eruptions are very frequent in skin inflammations called forth by mites and other small insects, by the hair of animals, or by the fibers of plants. They are rarely hemorrhagic. Wheal formation of a local nature results from the castor oil plant (E. Allilaire); urticarious papules from Pediculoides ventricosus in grain (Petroselli); pruriginous exanthema in laborers who have to busy themselves with the reloading and packing of figs (Legge, O'Donovan); lichenoid, urticarious eruption in packers of electric lamps, caused by the

packing straw (Legge), and in persons who thrash corn (H. E. Michelson). Hemorrhagic papules occurred in a gardener whose hands and feet were constantly wet (Piccardi); bluish-red, coarse, raised, itching nodules the size of a pea in a ship laborer who unloaded cotton seed, probably also caused by Pediculoides ventricosus (J. A. Nixon); flat wheals on the uncovered parts of the body from tetryl (William Ruxton); an eruption resembling strophulus called forth by barley dust, the cause being an Acarus (Hodara); an itching, papular exanthema which spread over the whole body was caused by feather pillows (Abramowitz); and a generalized exanthema after touching rungus, a tree of British North Borneo (J. F. Hornsey).

An edema, like an erythema, may retrogress or proceed to the formation of vesicles; retrogression is much more frequent in the case of an edema than in an erythema.

Vesication.—Vesication represents the third and last stage of the fully developed artificial skin inflammation. The vesicles are of the most varying size, from that of a pin's point up to that of an egg or an apple. They may be few or many, irregularly scattered or circumscribed; they may cover large portions of the skin or even the entire body. They may be isolated, or grouped and become confluent. The vesicles may be subcorneal, intraepidermal, or subepidermal. The roofs of the vesicles are correspondingly delicate and fragile, or firmer and of longer duration. The vesicles are mostly single. Their contents are clear, transparently yellowish, or cloudy—being dimmed by secondary infection with pus organisms. In rare cases the vesicle contents are hemorrhagic and correspondingly colored by pigments. The vesicles on the trunk and on the face are usually of short duration, the walls burst easily or are torn and the contents are discharged. The vesicle walls are more resistant on the extremities, particularly on the extensor surfaces, and are thickest on the palms of the hands and on the soles of the feet, where the vesicle covers are sometimes so thick that they appear as whitish spots or blebs. The walls of the vesicle are usually tense at the moment of discharge; later they become flabby and wrinkled, and after bursting form moist or dry broken epithelial fragments.

The vesicles are larger, as a rule, in the toxic skin inflammations and in bullous dermatitides; they show less tendency to confluence and are more resistant; in the artificial eczemas, the vesicles are smaller, there is a greater tendency to become united, their duration is shorter, and they exude more freely. In the toxic and artificial bullous dermatitides, if there is much erythema, development of the lesions is rapid; in the absence of erythema, lesions develop slowly, more gradually, and usually in the form of light-red nodules and in the artificial eczema forms (*eczema folliculare*). Two types may thus be distinguished: vesicles on a normal skin, and vesicles on an erythematous or diffuse edematous skin, as in burns. In the former the vesicular development forms nodules and papules which run together. The final result in both forms is discharging areas, the bases of which represent a smooth red surface from which serum oozes slowly, or as drop-

lets, or diffusely as from a sponge. These then dry up into transparent, honey-yellow crusts. These crusts may be very delicate, thin, and transparent, forming a yellow coating like varnish; or, drying in successive layers, they may cover the parts with an irregular, humpy mass. After long contact with the air, the crusts become darker—red or brown if colored with blood pigment, black from dirt or dust, and other tints from various color pigments. The crusts adhere firmly in the early stage or they are easily removable when the new, delicate epidermis begins to grow, loosening the scabs. When the serum dries up in thin translucent flakes, the rough, reddened, easily cracking appearance is characteristic. The majority of acute, artificial bullous skin inflammations heal perfectly, and the skin resumes its normal texture.

The size and number of lesions vary with different irritants. Knowles, for instance, finds innumerable, small, miliary vesicles after atropine; arsenic and mercury may also call forth small vesicular or small pustular eruptions (E. G. French, Oppenheim, and others). In primrose dermatitis, for instance, vesicular eruptions are found, sometimes with hemorrhagic contents (Riehl, Leiner, Jensen, and others); they are found also after contact with tomatoes (Everett S. Lain), Rhus toxicodendron, Laportea gigas and Laportea moroides (Kanngiesser), pyrethrum (Persian insect powder) (McCord, Kilker, and Minster), and with the various kinds of woods which are toxic for the hypersensitive, such as rungus (J. F. Hornsey) and cashew-nut (Howard Fox). The petroleum group may also produce the finest vesicular and pustular eruptions (Weyl); the latter are common in briquette workers (Leymann).

I was able to note large blisters after iodine, arsenic, and mercury, after the use of certain kinds of wood, petroleum, vaseline, tar, benzine, dyestuffs, etc. In Malays, Ridley saw both vesicles and pustules from contact with Gluta and Melanorrhoea, two kinds of Anacardium; Cash from satinwood; Hornsey from rungus; Sequeira observed large white blisters after contact with Anthemis cotula which contains acid of valerian; and Stillians reports similar eruptions from Peruvian balsam. During the war, particularly, large blisters arose from explosives and war gases (Flury and Wieland, Weber, MacLeod, Robson, and others). Small describes cheiropompholyx in soldiers who were employed in "clearing up" after an explosion; Oppenheim mentions the formation of large blisters after an explosion of mercury; Adamson describes blisters as large as a hen's egg from explosive substances in airship attacks; Thibierge notes cheiropompholyx caused by aeronautic bombs. Exanthemata with large blisters were seen by Brandtner after iodine; by Blaschko, Oppenheim, and others after lubricating oils; by Brocq after crude hard-coal tar; and Almquist describes pemphigoid, vesicular eruptions after mercury.

The grouping of these lesions into areas and the formation of plaques is also frequently observed; the lesions are described as sharply defined disks with vesicles situated peripherally and healing from the center. This type is rarer. Another variant is the infiltrated eczema plaques seen by H. E.

Alderson on the lower extremities of a woman employed in plucking tomatoes. E. Hoffmann, Koelsch, von Husen, Habermann, and others describe vesicular and bullous dermatitides from the effects of lime manure; there are erythematous and urticarious swellings on which vesicles and blisters develop. Gaucher, Gougerot, and Meaux Saint-Marc report on an herpetiform dermatitis after contact with mercury. The urticarious eczema seen in Mayence by Neisser, which Müller considers is a genuine war dermatosis, belongs to the same group. To this must also be added the observation made by W. E. Morgan who saw a dermatitis appear on himself after contact with alcohol-containing formalin; it broke out as small, itching circles arranged in the manner of herpes zoster, consisting of vesicles and crusts. Rhus can likewise call forth aggregated vesicles (Soyer); air bombs cause to appear on the face red and scaling spots covered with a few fine vesicles (Druelle).

A special place is occupied by those dermatitides and eczemas which assume a lichenoid character, some follicular, others extrafollicular; they are acneform hyperkeratotic, with and without pigmentation. Sometimes they may develop into papillary excrescences and large warty formations. Petroleum oils or coal tars and their derivatives are the responsible agents. These affections must be distinguished from the *vaselinoderma verrucosum* first described by myself which is a pure hyperkeratosis, rarely accompanied by any inflammatory phenomena, and due to the white kinds of vaseline with paraffin residues. This affection does not belong to the dermatitis group. The pure hyperkeratosis and the follicular inflammations must not be mistaken for the dermatitides which begin with nodules. The results may be the same as in artificial dermatitis and may appear as lichenification, as hyperkeratosis or as melanoderma (Ullmann, Koelsch, Oppenheim, Goldschmidt, Hoffmann, Kren, Blaschko, Galewsky, and others). I, myself, have observed follicular dermatitis and papular eczema, partly in groups, partly diffused, partly confluent, caused by benzine, vaseline, tar, glazier's putty, linseed oil, etc., and have shown such cases at the meetings of the Vienna Dermatological Society. In these cases the slight degree of itching and frequent shining surface of the nodules are striking, so that they call to mind lichen planus.

Luithlen also demonstrated a case of lubricating oil dermatitis with follicular and lichenoid forms which in parts presented the picture of a lichen ruber planus; E. Hoffmann has also seen nodules resembling those in lichen ruber in laborers working with coke. Keller reports this type with melanosis from arsenic. In four cases of lubricating oil dermatosis, Friedeberg says he has seen these faintly shining, light-brown nodules, with the typical glistening of lichen planus. Galewsky, Blaschko, Goldschmidt, and others saw eruptions similar to those in lichen pilaris after contact with lubricating oils. A follicular, severely itching dermatitis is caused by lemon oil (C. Guy Lane). Nander's case, on the contrary, is of a different type: the lesions were very firm, with light-red papules, always follicular, with necrotic centers. It is described

as a dermatitis due to solar oil, an unrefined oil employed on submarines.

The dry, scaling, fissured forms are special dermatitides which, without exactly being artificial eczema, as proved by their localization, course, lack of vesicles and moisture, very greatly resemble it at a certain stage. Among these are to be counted the dermatitides called forth by procaine, a modification of cocaine used by dentists (C. Guy Lane, Highman); the stomonal dermatitis of Prosser White (stomonal contains nitroglycerin and common salt); and, further, the dermatitis caused by the fibers of Indian hemp (Porias); and many others.

With regard to the end-results of artificial skin inflammations, we have already mentioned that in the toxicodermas, if the injurious substance is avoided, *restitutio ad integrum* most frequently follows. In case of excessive hypersensitiveness, or upon a continuous action of the toxin, *exitus letalis* may result in rare cases, as has been observed from contact with arsenic, mercury, quinine, etc. (Cazaneuve and others). In a large number of cases the *dermatitis artificialis sensu strictiori* slowly and gradually heals, or leaves some traces. A large number also end in the typical industrial eczema (*eczema artificiale*), and a third, smaller group exhibits a special termination with pigmentation, hyperkeratosis, and lichenification. These three skin changes may appear together, or one at a time, or also two at a time; they may show the most varied degree of intensity and extent, and last for a shorter or longer time. The most marked degrees of hyperkeratosis and hyperpigmentation are seen from arsenic and lubricating oil. Here also we must distinguish the epithelial proliferations and hyperkeratoses from those appearing without any previous inflammatory stage. The former never attain such high degrees and usually do not pass into epitheliomata; to these, therefore, the verrucose and papillomatous proliferations produced by O. Sachs from certain aniline paints do not belong. Epitheliomata are found in combination with eczema; they belong to the group of artificial dermatitis and proceed from a papillary body deprived of its epithelium.

In my opinion in all skin injuries we must sharply separate the components of a substance which cause inflammation from those which excite hyperkeratosis and acanthosis, so often reported from the use of the paraffin and coal oils and tars. Arsenical hyperkeratosis is usually localized on the palms of the hands and on the soles of the feet; the pigmentation is universal, or disseminated in patches. The hyperkeratoses from asphalt, naphtha, and tar are localized on the uncovered parts of the skin, such as on the back of the hands, on the forearms, and on the face; the pigmentation usually affects the same parts (Ullmann, Koelsch, Goldschmidt, E. Hoffmann, Galewsky, Almquist, Oppenheim, Brezina, Kaposi, Neumann, Rille, Kreibich, Pringle, and others). These changes may mask the original artificial dermatitis and make it difficult to isolate. Genuine cases of dermatitis followed by strong pigmentation and hyperkeratosis are recorded by Fischl after working in asphalt; also in the case of Friedeberg where meshlike pigmentation appeared. Morgan also has seen pigmentation after

formalin dermatitis; Knowles after belladonna; C. R. Straton after the Heracleum plant. Prosser White describes lichenification with hyperkeratosis in trinitrotoluene dermatitis; and S. Ayres after arsenic. Falling out of the hair is a rare consequence of artificial dermatitis; it occurs most often, perhaps, after arsenic (Cazaneuve and others), and after the most varied injuries from light. Vitiligo is still rarer. Jordan describes a case from mercury dermatitis—after the exanthema had vanished, symmetrically arranged vitiliginous spots appeared.

Industrial Eczema

When artificial dermatitis results in industrial eczema it signifies the persistence of all inflammatory symptoms. When the reddening, swelling, vesicular formation, moisture, skinning over, and scaling become irregular and repeated, and the scaling, lichenification, rhagades formation, and pigmentation are constantly recurring, we have a picture of a chronic dermatitis.

Localization of an industrial eczema depends on two factors: the delicacy of the particular part of the skin attacked, and the amount and character of contact with the agent. The back of the right hand and the backs of the fingers are chiefly affected, the palm being free; the skin at the base of the nail, being very delicate, is usually involved.

During remissions in the chronic stage, the color of the skin is rather pale and sallow, often sprinkled with gray and brown, or colored from the occupation—brown and black in carpenters, from wood polishes and corrosives; white in masons, from lime and plaster of Paris; dusty and pale in bakers, from the dough; pale and yellowish in laundresses, often also tinged blue from the blueing; in dyers and tanners, colored from the material in which they work, etc. Very often the skin bears the stigma of the trade or occupation followed, while at the same time temporary as well as permanent signs of the various vocations develop, such as coloring, callosities, changes in the nails, deposits, rhagades, excoriations, especially the characteristic horny formations, scars and cracks under the skin. We also find combinations with other occupational affections of the skin according to the kind of occupation or trade. Thus we may see burns in blacksmiths, bakers, casters, laundresses, etc.; caustic ulcers in nickel-platers, galvanizers, tanners, etc.; oil comedones and acne in refiners and petroleum workers; tar acne and pigmentation in workers on briquettes, on suberic stones, etc.; tuberculosis verrucosa cutis and scabies in shoemakers. Frequently other skin affections, not acquired by the vocation, are recognizable in chronic industrial eczemas. They are even sometimes equally to blame for the appearance of the eczema (Riehl).

Seborrhea, ichthyosis, and psoriasis vulgaris may be present, as well as eczematous lesions of the skin. Atrophy of the skin may be a stigma of the vocation, such as the weather-beaten skin of gardeners, field laborers, masons, etc.; sometimes, though rarely, an industrial eczema ends in atrophy—for instance, the thin glossy skin of the back of the hands in laundresses, cooks, etc. As a rule the skin is thickened in artificial eczema. The thickening may be slight, or it may be

very marked and make it impossible to fold the skin. On the palm of the hands and volar face of the fingers it produces eczema tyloticum, with deepened and very pronounced lines; it is quite impossible to close the hand or flex the fingers unless forcibly done and with pain. Superficial and deep rhagades (*eczema rhagadiforme*) are often seen in the thickened skin. These usually run vertically to the longitudinal directions of the hand and fingers; they usually follow the lines of the joints, particularly on the fingers, but may also run both lengthwise and crosswise. In the roentgen hand (Unna), atrophies and telangiectasias are found beside the thickening, rhagades, and furrows. In other industrial eczemas the lines become confused, indistinct, or lost.

Vesicles, oozing, and crusting are least developed in the chronic or quiescent stage of industrial eczema. At the circumference of the areas can be seen isolated, irregularly defined crusts up to the size of a pea, under which are isolated, red nodules and papules. Actual vesicles and blisters develop rarely, except during an exacerbation when itching is very violent. In every case of chronic eczema, however, we can produce moisture by rubbing the part with diluted solution of caustic potash. This effect is said to be characteristic of chronic eczemas. Small, more or less firmly adherent scales are constantly seen; they may be powdery or in lamellae; more rarely they are arranged in white adherent layers (*eczema psoriasiforme*). The color is generally gray, but may be brown and stained by dyes or dirt.

The change in the finger nails is caused by injury to the wall and bed of the nails. This may be primary, when the injurious substance directly affects the nails, as in the *onycholysis partialis* of laundresses (Oppenheim); in the changes caused by arsenic, chrome, formalin, caustic lime, etc., onychia is most frequent. The nails are reddened, slightly swollen, and often scaling; they are dry, brittle, cracked, furrowed lengthwise and crosswise, lusterless, and hard. Complete loss of the nail ensues from severe inflammation and secondary infection.

We very often also find the subungual keratoma, in which the nail is thickened, brittle, and lusterless; it is detached from its bed, especially at its free edge, by a brittle, horny substance which appears in parallel masses between the nail and the finger tip. Subungual keratoma may involve all the fingers, or one or more. *Koilonychia* usually develops on one finger, particularly the nail of the thumb. The nail gets detached at the ends in a concave, not a convex, curve; it is hollow like a platter, usually thinned, and of normal luster and smoothness. *Onycholysis partialis* is more rare. It is not the type seen in laundresses, but the nails are dry and brittle, detached in part from their bed, and break off. The edge is scalloped, or frayed and irregular, and a part of the nail-bed lies exposed; later on its surface grows callous. It should, further, be mentioned that in the case of a long-standing industrial eczema the nails of the toes also may be pathologically affected (see Heller's monograph on affection of the nails).

Frequent secondary infections with pus organisms complete the clinical picture of an industrial eczema of the hands. Infection of the vesicles by

staphylococci causes pustulation and progressive inflammation. Impetigo staphylogenes complicates the picture and the causes; inflammation of the lymphatic vessels and glands (lymphangitides and adenitides), furuncles, and phlegmonas may arise. Furuncles often appear in great number during and after the healing of an eczema. In rare cases pyodermias are induced by the pus enzymes. A rare occurrence is erysipelas due to Fehleisen's streptococcus. Hyphomycetes may be implanted on an industrial eczema giving the characteristics of eczema marginatum—sharply defined, round, disk-like areas having peripheral nodules, or vesicles or pustules with more or less tendency to fade in the center. Diagnosis is only possible with the aid of a microscope and a culture. These secondary infections must not be confused with primary *tinea superficialis vesiculosa* met with in stable employees, drivers, barbers, and others.

On other parts of the skin an industrial eczema exhibits the same fundamental characteristics as on the hands, but is modified by the varying texture of the skin. Lichenification, scaling, nodule and papule formation are more evident. Oozing, swelling, vesicular formation, and reddening are less pronounced. During an exacerbation they may dominate the picture and mask the other symptoms. The portions of the skin which are uncovered usually suffer most: such as the face, forearms, upper arms, neck, throat, and adjoining parts of the breast. Parts of the skin, which by their position are *loci minoris resistentiae*, readily succumb, such as: the axillary folds, the bends of the elbows and knees, the inner side of the thighs, and the scrotum. Finally, places where idiopathic, seborrheic eczema tends to become localized, also the anterior and posterior sweat-areas, such as the axillary cavity and the mons veneris, are readily affected.

Restitutio ad integrum is possible in every case of industrial eczema. Every industrial eczema, even the severest, may heal on cessation of the work and with suitable therapy without leaving a trace. This is not the rule, however. Usually a light-yellow or brown pigmented skin, somewhat thickened, distinctly raised and with sparse or missing hair, remains, which may on the slightest irritation respond with a new outbreak of dermatitis.

In conclusion, a list of those occupations and industries which are most frequently attacked by industrial eczemas is given. The list does not claim to be complete. Each day creates new branches of industry and employment for the workers which may lead to eczema. Persons who live only for pleasure also may become affected by, so to speak, industrial eczema. Cocottes and "men about town" show eczemas which proceed from extreme care of the skin, and from the beautifying and rejuvenating remedies which they use.

Heat, soot, dust, and irritating, caustic, coloring substances—all inflict superficial injuries. Men who perspire profusely while at work and who, after work, clean themselves with a great deal of soap and brushing, and the handlers of turpentine, chloride of lime, and other biting substances are liable to these troubles. The most frequent sufferers are the following:

Art painters, bakers, blacksmiths, canned goods workers, carpenters, workers in chemical products, confectioners, cooks, dissecting room servants, dyers, feather trimmers, furriers, galvanizers, gardeners, glaziers, hatters, laundresses, locksmiths, macadamizers, masons, machine oilers, matchmakers, metal workers, miners, mother-of-pearl carvers, nurses, painters, paraffin workers, pharmaceutic products workers, petroleum workers, platers, photographers, physicians, plasterers, polishers, provision dealers, roentgen-ray workers, spinners, beef smokers, stockers, tanners, tar workers, tunnel workers, varnishers, makers of wall-paper, and whitewashers.

BOOK REVIEWS

SUNSHINE AND OPEN AIR. By *Leonard Hill*, M.B., F.R.S., Director, Department of Applied Physiology, National Institute of Medical Research. Pp. 131 with illustrations. London: Edward Arnold & Co., 1924.

Dr. Leonard Hill in this valuable contribution to the science of sunshine, after alluding to the delights of dwelling in the higher Alps, points to the appropriate patients and refers to those who are unfitted for treatment in an Alpine winter climate. In the latter category he places elderly people with atheroma, high blood pressure, and large pulmonary cavities, and the feeble emaciated with poor digestion.

The sun is the one essential source of warmth. If the total radiation from all the stars, incident upon 1 square centimeter, were collected and conserved, it would require from one hundred to two hundred years to raise the temperature of 1 gm. of water 1°C., whereas the solar rays, which reach the earth's surface, can produce the same effect in about one minute.

Winter alpine health resorts should be placed above the clouds, which seldom rise higher than 4,000 feet. In the Alps the summer is rainier than the winter. In long, wet, sunless periods, not infrequent in British winters, consumptive patients undergoing open-air treatment naturally mope. They suffer more from catarrhal conditions. The better ones may carry through with plenty of exercise and a cheerful disposition. The cure of surgical tuberculosis halts in these wet seasons. All lack the stimulation of sunshine. It is in this respect that the Alpine climate offers such great advantage.

Certain poisons can produce a toxic effect on the respiratory membrane in concentrations as low as 1 in 100,000,000. The chemical purity of the air, apart from dust and microbes in rooms occupied by people, is not impaired in such a way as to be of any physiologic significance, not even when these rooms are crowded and ill-ventilated. In mines and hermetically sealed chambers, and in the case of noxious fumes arising from trade processes, chemical purity must, of course, be maintained by adequate ventilation. In ordinary crowded rooms, however, it is massive infection from carriers of pathogenic microbes, and the physical properties of the air—its moisture and stagnation—which matter. There is no organic poison exhaled or given off from the body, as has been supposed.

Evaporation from the skin is essential for the maintenance of health. The capacity of air for holding water vapor increases with the temperature. For example, with a temperature of 31°F. the maximum weight of the water absorbed by the air is 2 grains per cubic foot; with a temperature of 101° it is 20 grains per cubic foot. The humid air of damp houses has an effect similar to mist; the air "strikes cold and damp," or, if warmed up,

diminishes evaporation from the body and is oppressive. Meteorologic reports give the relative humidity but they should also give the physiologic-saturation deficit which from a physiologic standpoint is more important.

Acute inflammations of the pharynx, tonsils, and nose are caused by various bacteria, probably filter passers in the first case, followed by secondary infections with pneumococcus, streptococcus, Pfeiffer's bacillus, etc. The popular view is to attribute all catarrhs to exposure. Men largely living open-air lives are free from "colds." After the initial febrile stage is over, the end stage of a catarrh is shortened by open-air treatment. A blow at the seaside, with salt spray in the air to help, a motor ride through the bracing air, a day spent easily on the golf course without overfatigue will dissipate the end of a catarrh.

The more people pollute the atmosphere with smoke and consequent fogs, cut themselves off from sunlight, shut themselves up to avoid cold, and live sedentary "hothouse" lives, disordering their economy by overeating and at the same time reducing the combustion of food through body heat stagnation, the more will they suffer and die from catarrhal complaints. It has been shown that a zone within 1 meter of a consumptive patient is particularly dangerous.

Cool breezes blowing round the head, the radiant heat of the sun, and a warm ground to stand on, are the ideal outdoor conditions. The reverse obtains in a heated room. In crowded rooms infection takes place from saliva spray, sneezed, coughed, or spluttered out in speaking.

Much is made of the ill effects of mouth-breathing, but such breathing is natural to the runner and to the panting, heated dog. It is the chronic catarrhal infection, causing continuous mouth-breathing, which depresses the health.

On cloudy days, far less light reaches our cities than reaches the Alpine heights. Of the light which does penetrate the smoke-befouled atmosphere, the citizen receives little. Shutting himself up in close rooms, as he does nearly all day, while engaged in sedentary occupations, such bright sunlight as he receives is filtered through glass and robbed of its ultraviolet rays.

The mountain sun contrasted with that of the plains is richer in ultraviolet rays and more luminous, and has greater heating power. Luminous rays pass almost unimpaired through water, whereas infra-red rays are absorbed. Ultraviolet rays have very little heating power but are powerful in producing chemical change and in killing living cells. They are absorbed by ordinary glass but not by quartz; they are also absorbed by protein solutions or living tissues, and so penetrate a very little way.

In the case of an oil lamp, 97 per cent. of the energy is in the infra-red region; in the case of an electric incandescent lamp, 95 per cent. On the other hand, the efficiency of the glow organ of the firefly appears to be 100 per cent., all the radiation being luminous. The mercury vapor lamp gives a bright line, not a continuous spectrum; of red and infra-red rays, it gives small amounts arising from the heating of the quartz container. In the case of a water-cooled mercury vapor lamp, the energy of the ultraviolet is more than that of the lumi-

nous—*e.g.*, 60 to 70 per cent. of the total radiation, a ratio much greater than is the case with the sun or the arc lamp.

The effect of a slope is very great. One of 35° facing south at latitude 35° receives the same amount of sun energy on a clear day as a horizontal surface at the equator. On the other hand, a slope of 45° facing north at 45° latitude is equal in this respect to a horizontal surface at the North Pole. Hence the great importance of the position of sanatoria.

For recording both brightness and the intensity of the ultraviolet rays Dorno uses the photo-electric method.

It is important to note that the clear blue sky is estimated to give more ultraviolet than the sun at its zenith, and far more than the sun at low altitudes. Heliotherapy can then be carried out in the shade and on cloudy days if the exposed body is kept suitably warm.

There are no comparative measurements of ultraviolet rays, total radiation on the horizontal surface, etc. The want of such data obviously should not continue, for accurate measurement is the basis of a sound heliotherapy. Dorno has measured the radiant energy of the Alpine sun by Angström's pyrheliometer and pyranometer. The meteorologic office at South Kensington uses Callender's pyrheliometer. For estimating light by photographic means J. M. Eder's gray wedge photometer may be used. A method of measuring ultraviolet rays has been worked out by Webster, Eidinow, and Dr. L. Hill, by the bleaching of a standard solution of acetone and methylene blue.

Theory now recognizes that every chemical reaction is started by radiant energy.

According to the physicist the ultimate units of which matter is composed are of two sorts: protons (or hydrogen nuclei) and electrons. Protons are units of positive electricity; electrons are units of negative electricity. Protons are about 1,840 times as heavy as electrons, but probably smaller. Radioactive elements give out three sorts of rays, called alpha-rays, beta-rays, and gamma-rays. The gamma-rays are analogous to light, but consist of very much shorter waves. The alpha-rays consist of nuclei of helium, the second element in the series. The beta-rays consist of electrons.

While some 20 per cent. of the red-yellow rays pass through a rabbit's ear, only 1 per cent. of the blue-violet rays do so, and none of the ultraviolet rays. The injurious action of excessive light on the retina is due to visible rays and not to ultraviolet rays.

An electric glowlamp placed in the mouth of a white man is visible in a dark room as a dull red glow. Not so in the case of the negro. The waves of sunlight which are active in producing pigment are the ultraviolet rays present in the high, clear sun; hence the pigmentation which comes about in the spring, on exposure after the winter bleaching. Ordinary window glass allows the passage of no rays below 313$\mu\mu$ and few below 330, and so pigmentation does not take place under glass.

The visual purple appears to act as a sensitizer in the retina. In the iris the pigment acts both as a sensitizer and as a screen. Through it contraction of the sphincter muscle of the

excised iris is caused on exposure to light. In the skin the pigment acts as a screen, protecting the deeper tissues from excess of radiation, and as a converter of light into heat, thus acting as a sensitizer to the sensory nerves, exciting vasodilatation and sweating. Injection of less than a milligram of hematoporphyrin sensitizes the mouse's uterus to visible light. Sensitization to light opens up a new field of therapeutics hardly yet explored.

Sunstroke is produced by local heating of the brain as well as by general heating of the whole body, while heat stroke is caused wholly by the latter. Heat stroke can be prevented by induction of artificial sweating, by wetting the patient with a spray and blowing upon him with a fan.

Excessive sweating and drinking of water robs the body of chlorides and causes cramps. The drinking of a weak solution of salt is found beneficial for miners, stokers, etc., preventing cramp.

Bacteria are killed more rapidly by ultraviolet rays at warmer than at colder temperatures.

Owing to the penetration of tissues by the visible rays, to the absorption of these rays at deeper levels, and to their high relative proportion in sunlight, a far greater intensity of sunlight can be borne on the skin without burning than is the case with artificial light. To the local heating of the blood and subcutaneous tissue by the visible rays Sonne ascribes the curative power of light.

The ultraviolet rays penetrate to and act on the deeper cells of the epidermis and thus exert a most important curative power.

Febrile cases should not be exposed to the sun. It is the nonfebrile case whose cure is promoted thereby. Febrile cases should be exposed to cool air and to the ultraviolet rays coming from the sky.

Light treatment has its effect by causing erythema and transudation of lymph rather than by directly killing the microbes.

Exposure to direct sunlight and out-of-door air promotes in a very wonderful way the health, the bodily vigor, and the longevity of animals which otherwise are unable to adapt themselves to markedly adverse environmental conditions.

While in warm summer weather or in hot countries the production of the sedentary person is little more than the basal ration, moderate work suffices to combat the cold of winter. The energy production of hard work being five times, and that of intense work (Alpine climbing) ten times that of the sedentary person, a powerful thermolytic mechanism is required to prevent hyperthermia; hence the evolution of the "emergency" mechanism of cooling—evaporation.

The cooling power of the air can be measured by the kata-thermometer.—*D. A. Coles.*

HELIOTHERAPY. By *A. Rollier*, M.D. London: Henry Frowde & Hodder & Stoughton, 1923.

The habit of wearing clothes over the greater part of the body results in anemia and atrophy of most of the skin. Vasomotor reflexes become sluggish through disuse, and great susceptibility to heat and cold results.

Technic of the Sunbath

Careful posology is essential. Eventual success depends on initial accli-

matization. The amount and duration of insolation must be dependent on the patient's reaction to sunlight. Fresh and relatively cool air is an essential accompaniment of heliotherapy.

In open tuberculosis heliotherapy is much less certain and much slower in action than in the case of closed lesions. A closed cold abscess is much more amenable to heliotherapy; if the abscess is open, free drainage is essential.

Tuberculosis of the Spine.—1. Treatment should commence with a complete rest in the dorsal position.

2. When muscular contraction has diminished and pain has ceased, the ventral position is more advantageous, except in the acute stages of caries.

The patient is allowed to get up only when recalcification is advanced. This is shown by the absence of all pain and by an X-ray examination. A strong support—*e.g.*, perforated celluloid—will be required at first, and a less rigid one later. It must be carefully molded to fit exactly, but must not be made of plaster.

Tuberculous Joints.—In tuberculous affections of the joints suitably adjusted extension is essential. The doses of heliotherapy must always be carefully regulated but especially in tuberculous peritonitis.

Tuberculous Glands.—Tuberculous lymphatic glands generally heal rapidly under heliotherapeutic treatment. If aspiration is employed, the needle should be inserted obliquely in the healthy skin, in order to avoid scarring.

Pulmonary Tuberculosis.—In pulmonary tuberculosis the chest should not be exposed to insolation until the rest of the body has been fully acclimatized to the treatment.

Advantages

The advantages of purely heliotherapeutic treatment are:

1. All the organisms are dealt with, without breach of surface.

2. There is no opening of lymphatic channels with consequent risk of generalization.

3. There is no pain.

4. A good supple scar is formed. Old and keloid scars tend greatly to improve.

5. It is the only treatment the effects of which are generally as well as locally curative.

The chief contraindication to heliotherapy is "when a patient is very weak, with much toxaemia and hectic fever;" others are acute nephritis, arteriosclerosis, myocarditis, and valvular cardiac disease, if these are of a severe character.

Tubercle bacilli enter the system chiefly by the alimentary tract or by the respiratory tract—*e.g.*, in milk or in sputum. As three-fourths of the adult population are infected with tubercle bacilli, every effort should be made to increase the resistance of the body to the disease.

The following instructive chapters at the end of the book, by three authorities of experience, will well reward careful study, and cannot be adequately dealt with in this abstract: "The Scientific Basis of Heliotherapy," by A. Rosselet, M.D., D.Sc.; "The Radiological Diagnosis of Osteo-Articular Tuberculosis and the Radiographic Control of the Clinical Results of Heliotherapy," by H. J. Schmid, M.D.; "The Adjuvants of Heliotherapy," by E. Amstad, M.D.; and "Heliotherapy of Non-Tuberculous Diseases," by E. Amstad, M.D.—*D. A. Coles.*